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Radiological Health Data

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VOLUME V, NUMBER 1

JANUARY 1964

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and foreign governments. Pertinent original data and interpretive papers are invited from investigators. Accepted material will be appropriately credited. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

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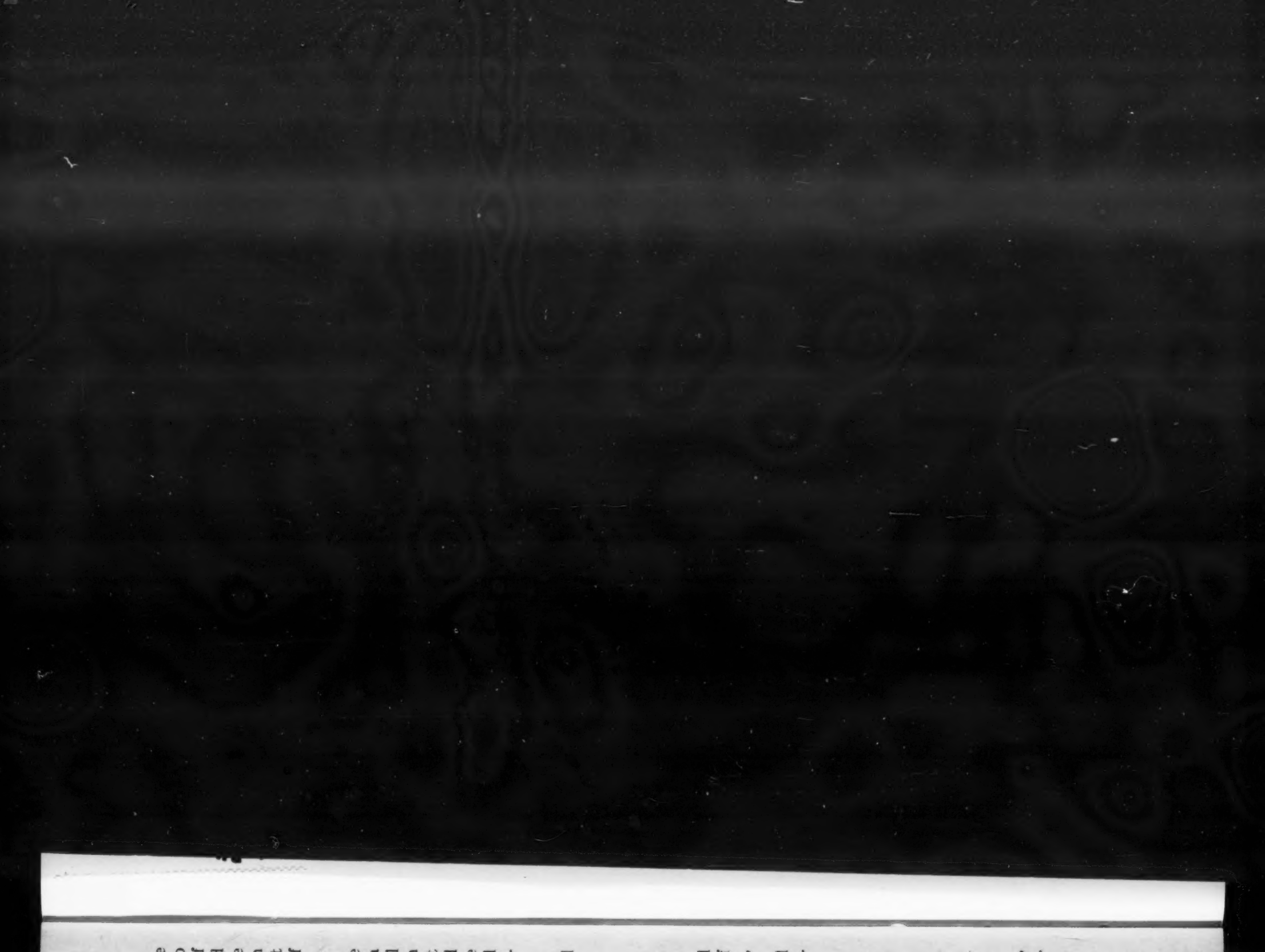

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RADIOLOGICAL HEALTH DATA

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Early indications of possible fission product activity fluctuations in various phases of the environment are detectable by continuous surveillance of gross beta activity in air and precipitation. This form of surveillance does not provide sufficient information for assessing human exposure due to fallout, but it forms a basis for an alerting system and is useful in determining when and where to conduct more intensive monitoring of radioactivity in food, milk, and water.

Gross beta concentrations in air are presented in reports from the Public Health Service, the Canadian Department of National Health and Welfare, the Mexican National Commission of Nuclear Energy, and the Pan American Health Organization. September 1963 data from three networks were combined and are presented graphically by means of isogram lines on a map of North America.

1. RADIATION SURVEILLANCE NETWORK, SEPTEMBER 1963

Division of Radiological Health,
Public Health Service

The Radiation Surveillance Network (RSN) is made up of 73 sampling stations distributed throughout the United States as indicated in figure 1. Most of these stations are operated by State Health Department personnel.

Air

Airborne particulates are collected continuously on a carbon-loaded cellulose dust filter 4 inches in diameter. A volume of about 1800 cubic meters of air is drawn through the filter during the 24–hour sampling period by a high volume centrifugal blower. Field estimates of the gross beta activity of airborne particulates are derived by comparing portable survey meter readings of these filters with readings taken from a Sr^{90}–Y^{90} standard. This determination is usually made about 5 hours after the end of the sampling period to eliminate interference from naturally-occurring radon daughters. The Network's station operators report their field estimates daily to the Radiation Surveillance Center, Division of Radiological Health, Washington, D.C.

The filters are then forwarded to the Radiation Surveillance Network laboratory in Rockville, Maryland, for a more refined measurement using a thin-window, gas-flow proportional counter, calibrated with a 38,300 pc Sr^{90}–Y^{90} standard. Each filter is counted at least 3 days after the end of the sampling period and is recounted 7 days later. The initial 3-day aging of the sample eliminates interference from naturally-occurring radon and thoron daughters. From the two counts, which are separated by the 7-day interval, it is possible to estimate the age of fission products and to extrapolate the activity to the time of collection. The extrapolation is performed by using the Way-Wigner formula: $AT^{1.2} = C$ (*1*).[1] The daily concentrations and estimated age are reported by the PHS in a monthly RSN report (*2*).

The September 1963 fission-product beta concentrations in surface air (extrapolated to the time of collection) are given in table 1. RSN

[1] In this expression, A is the activity, T is the time (in any time unit) after fission product formation, and C is a constant equal to the activity at T = 1.

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS, SEPTEMBER 1963

data are presented with Canadian and Mexican air data in the form of isogram lines in figure 6.

Precipitation

Continuous sampling for total precipitation is conducted at most stations on a daily basis, using funnels each having a collection area of 0.4 square meter. A 500-ml aliquot of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory for analysis. If the collected sample is between 200 and 500 ml, the entire sample is evaporated. When a sample is smaller than 200 ml (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made.

In the laboratory the gross beta concentration of precipitation is determined by counting the evaporated sample by the same method used for analyzing the air filters, including the extrapolation to time of collection. Deposition for the sample is determined by:

$$D = \frac{CP}{1000}$$

where D is the deposition in nc/m^2, C is the concentration in pc/liter, and P is the depth of precipitation in mm for the individual sample. The individual values of deposition and depth of precipitation are totaled for the month, and the average concentration, $\overline{C}$, is determined by:

$$\overline{C} = \frac{\Sigma D}{\Sigma P} \times 1000$$

The September 1963 average concentrations and total depositions are given in table 2.

Profiles

The profiles of the monthly average fission product beta activity of airborne particulates for each RSN station covering the period of time from the formation of the network in 1956 to the end of 1960 were published in the July 1961 issue of *Radiological Health Data*. In recent issues, several profiles have been updated each month. The last column of table 1 gives the issue having the most recent profile for each station. Seven profiles are updated in figure 2.

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, SEPTEMBER 1963

[Concentrations in pc/m³]

Station location		Number of samples	Maximum	Minimum	Average[a]	Last profile in RHD
Alaska:	Adak	28	2.7	<0.10	0.70	Nov. 1963
	Anchorage	27	4.3	0.15	1.0	Jul. 1963
	Attu	30	2.6	<0.10	1.1	Dec. 1963
	Fairbanks	29	5.6	0.16	1.7	Aug. 1963
	Juneau	21	2.9	0.17	0.70	Sep. 1963
	Kodiak	21	2.1	<0.10	0.62	Oct. 1963
	Nome	0	—	—	—	Feb. 1963
	Point Barrow	30	3.4	<0.10	1.2	Jan. 1964
	St. Paul Island	24	2.1	<0.10	0.71	Apr. 1963
Ariz:	Phoenix	29	3.8	0.40	1.3	Sep. 1963
Ark:	Little Rock	29	4.0	0.42	1.9	Sep. 1963
Calif:	Berkeley	27	2.4	0.25	1.2	Oct. 1963
	Los Angeles	18	3.4	0.68	2.4	Feb. 1963
Canal Zone	Ancon	14	0.22	<0.10	<0.12	[b]
Colo:	Denver	28	4.2	0.21	2.1	Nov. 1963
Conn:	Hartford	29	4.0	0.39	2.2	Oct. 1963
Del:	Dover	16	4.5	0.11	2.9	Aug. 1963
D.C:	Washington	29	4.4	0.67	2.5	Mar. 1963
Fla:	Jacksonville	28	2.6	0.14	1.5	Oct. 1963
	Miami	27	1.6	<0.10	0.72	Feb. 1963
Ga:	Atlanta	4	3.3	3.03	3.1	Jul. 1963
Guam:	Agana	26	0.49	<0.10	0.2	Mar. 1963
Hawaii:	Honolulu	28	3.4	<0.10	1.7	Nov. 1962
Idaho:	Boise	29	4.6	0.74	2.6	Dec. 1963
Ill:	Springfield	28	3.4	0.67	1.8	Oct. 1962
Ind:	Indianapolis	29	4.0	0.77	2.2	Jul. 1963
Iowa:	Iowa City	27	3.6	0.44	1.5	Jan. 1964
Kans:	Topeka	28	3.6	0.71	1.7	Jul. 1963
Ky:	Frankfort	26	7.4	0.34	2.4	Mar. 1963
La:	New Orleans	29	2.7	0.28	1.5	Nov. 1962
Maine:	Augusta	29	4.9	0.16	2.4	Mar. 1963
	Presque Isle	23	3.3	0.16	1.7	Nov. 1963
Md:	Baltimore	19	3.6	0.55	2.3	Nov. 1963
	Rockville	20	4.3	0.49	2.5	[b]
Mass:	Lawrence	29	5.2	0.25	2.4	Aug. 1963
	Winchester	29	4.5	0.37	2.0	[b]
Mich:	Lansing	29	4.5	0.53	2.3	Apr. 1963
Minn:	Minneapolis	27	3.1	0.47	1.6	Mar. 1963
Miss:	Jackson	26	3.4	0.69	2.0	Mar. 1963
	Pascagoula	1	1.0	0.96	1.0	Dec. 1963
Mo:	Jefferson City	29	3.0	0.55	1.6	Nov. 1963
Mont:	Helena	29	4.4	0.58	2.2	Nov. 1963
Nebr:	Lincoln	15	2.6	0.48	1.5	Apr. 1963
Nev:	Las Vegas	26	8.0	0.88	3.5	Jul. 1963
N.H:	Concord	19	4.6	1.4	2.8	[b]
N.J:	Trenton	29	3.6	0.71	2.1	Oct. 1962
N. Mex:	Santa Fe	21	4.1	0.40	1.5	Dec. 1963
N.Y:	Albany	26	6.2	0.46	2.7	Jul. 1963
	Buffalo	25	6.2	0.62	3.4	Nov. 1963
	New York	13	2.9	0.51	1.7	Dec. 1963
N.C:	Gastonia	26	3.6	0.63	1.9	Jan. 1964
N. Dak:	Bismarck	28	3.3	0.26	1.8	Feb. 1963
Ohio:	Cincinnati	20	3.8	0.83	2.2	Aug. 1963
	Columbus	30	4.1	0.74	2.3	Feb. 1963
	Painesville	30	6.2	0.74	3.1	Oct. 1963
Okla:	Oklahoma City	28	3.0	0.33	1.4	Apr. 1963
	Ponca City	26	1.9	0.13	0.93	Oct. 1963
Ore:	Portland	29	4.3	1.04	2.2	Oct. 1963
Pa:	Harrisburg	26	7.3	0.17	2.6	Jan. 1964
P.R:	San Juan	29	1.0	0.16	0.47	Apr. 1963
R.I:	Providence	27	5.0	0.39	2.3	Jan. 1964
S.C:	Columbia	22	2.6	0.23	1.3	Dec. 1963
S. Dak:	Pierre	29	3.5	0.55	1.5	Sep. 1963
Tenn:	Nashville	12	4.2	1.5	3.2	Jan. 1964
Tex:	Austin	29	3.2	0.29	1.5	Aug. 1963
	El Paso	29	2.9	0.36	1.1	Jan. 1964
Utah:	Salt Lake City	30	5.4	0.51	2.3	Aug. 1963
Vt:	Barre	27	6.4	0.55	3.2	Sep. 1963
Va:	Richmond	28	3.3	0.32	1.7	Sep. 1963
Wash:	Seattle	28	2.0	0.36	1.0	Jul. 1963
W. Va:	Charleston	25	4.9	0.16	1.9	Dec. 1963
Wisc:	Madison	29	4.2	0.48	1.9	Sep. 1963
Wyo:	Cheyenne	29	5.0	<0.10	2.6	Aug. 1963
Network summary		1,818	8.0	<0.10	1.9	

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10% of the average, a less-than sign is placed in front of the average.

[b] Initial profile scheduled for a future issue.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, SEPTEMBER 1963

Station location		Average concentration (pc/liter)	Total deposition (nc/m²)
Alaska:	Anchorage	740	16
	Fairbanks	1,400	3.8
	Juneau	590	100
Ark:	Little Rock	540	19
Calif:	Berkeley	3,800	12
	Los Angeles	950	3
Colo:	Denver	460	14
Conn:	Hartford	400	36
D.C:	Washington	490	29
Fla:	Jacksonville	480	68
	Miami	[a]<400	<7.4
Ga:	Atlanta	[b]	[b]
Idaho:	Boise	[b]	[b]
Ill:	Springfield	520	6.4
Ind:	Indianapolis	1,200	8.8
Iowa:	Iowa City	480	4.7
Kans:	Topeka	740	12
Ky:	Frankfort	1,200	17
La:	New Orleans	420	95
Maine:	Augusta	640	35
	Presque Isle	630	74
Md:	Baltimore	460	14
Mass:	Lawrence	780	75
	Winchester	1,000	92
Mich:	Lansing	620	26
Minn:	Minneapolis	510	56
Miss:	Jackson	720	5
Mo:	Jefferson City	420	16
Mont:	Helena	1,400	17
Nebr:	Lincoln	<400	<17
Nev:	Las Vegas	610	14
N.J:	Trenton	530	14
N. Mex:	Sante Fe	510	21
N.Y:	Albany	<400	<23
	Buffalo	[b]	[b]
N.C:	Gastonia	400	31
N. Dak:	Bismarck	1,300	24
Ohio:	Columbus	600	12
	Painesville	750	17
Okla:	Oklahoma City	<400	[c]
	Ponca City	<420	<43
Ore.	Portland	420	10
Pa:	Harrisburg	480	27
P.R:	San Juan	<400	<78
R.I:	Providence	540	55
S.C:	Columbia	440	53
S. Dak:	Pierre	520	28
Tenn:	Nashville	720	19
Tex:	Austin	410	7
	El Paso	400	5
Utah:	Salt Lake City	510	22
Vt:	Barre	1,100	30
Va:	Richmond	<400	<28
Wash:	Seattle	1,200	18
W. Va:	Charleston	490	16
Wisc:	Madison	490	40
Wyo:	Cheyenne	430	24

[a] The minimum concentration reported is 400 pc/liter.

[b] No evaporated sample received.

[c] Data not available.

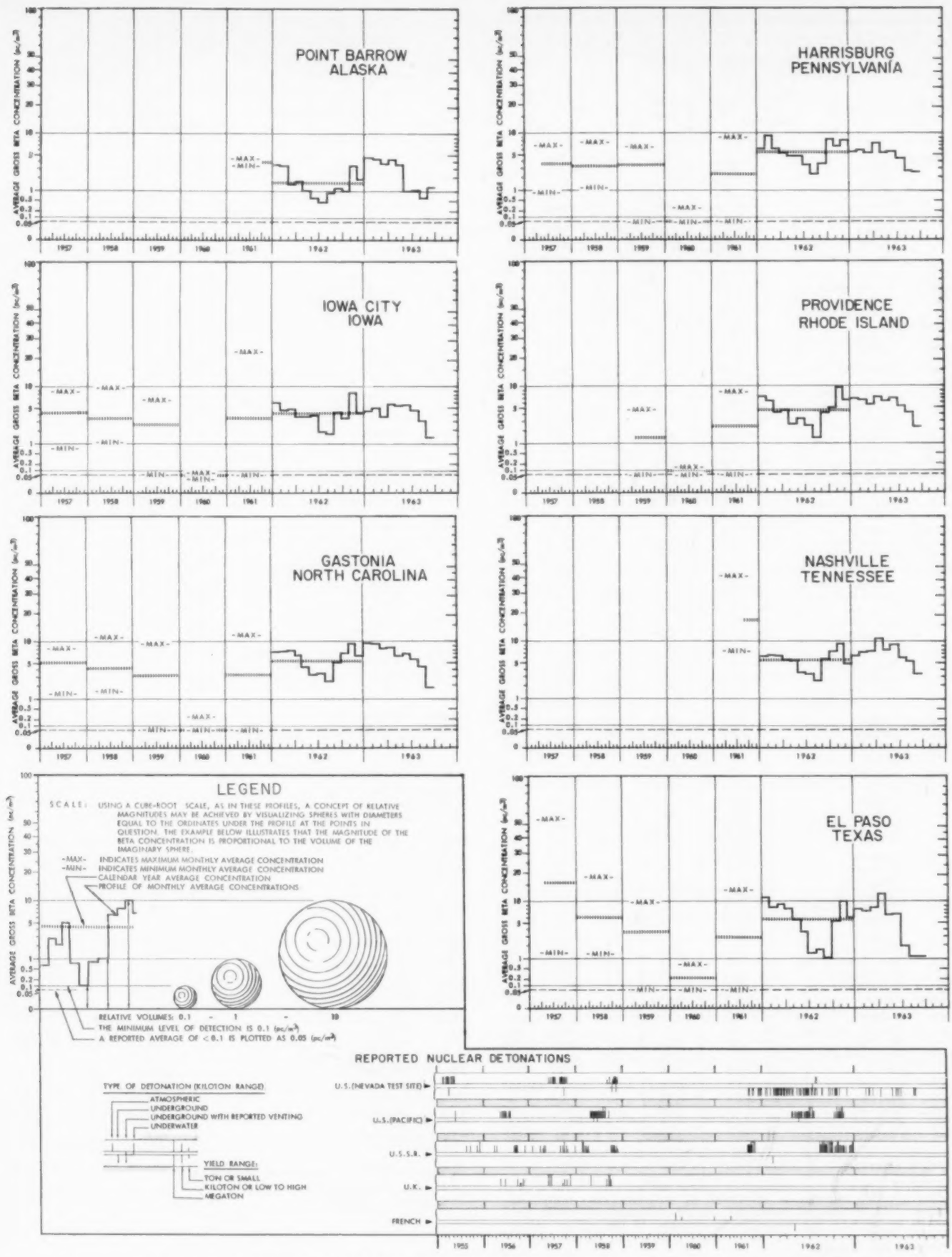

FIGURE 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR—RADIATION SURVEILLANCE NETWORK, 1957–SEPTEMBER 1963

2. NATIONAL AIR SAMPLING NETWORK, THIRD QUARTER 1963

Division of Air Pollution,
Public Health Service

The necessity of having basic data on the nature and extent of air pollution throughout the United States led to the organization of the National Air Sampling Network (NASN) in 1953. The NASN analyzes air samples for the total quantity of suspended particulate matter, benzene-soluble organic matter, and gross beta radioactivity. Selected samples are also analyzed for nitrates, sulfates, and certain metals. These analyses aid in the detection of trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality.

Gross Beta Activity in Air

NASN stations (see figure 3) are manned by cooperating Federal, State, and local agencies. The current basic network consists of 110 sampling stations which operate every year in 73 large cities and 37 nonurban areas. In addition, there are stations in 130 cities which operate every other year. Thus, there are 240 sampling stations in the NASN Network, of which 175 are active in any given year.

Continuous 24-hour samples of suspended particulate matter are taken at each station. The samples, representing approximately 2,000 cubic meters of air, are collected on glass fiber filters on a biweekly random sampling schedule. They are then sent for analysis to the network laboratory at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio. Third quarter 1963 data appear in table 3.

Gross Beta Activity in Precipitation

The present reporting of gross beta activity in precipitation originated in 1959 when a precipitation collection and analysis program was established by the Weather Bureau Re-

FIGURE 3.—NATIONAL AIR SAMPLING STATIONS, 1963

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR—NASN, THIRD QUARTER, 1963

[Concentrations in pc/m³]

Station location		Number of samples	Maximum	Minimum	Average
Ala:	Birmingham	7	10.0	0.2	3.5
	Huntsville	6	10.5	3.2	7.5
	Montgomery	7	5.2	1.4	3.4
Alaska:	Anchorage	7	7.7	0.4	2.7
	Pt. Woronzof[a]	7	7.6	0.3	3.8
Ariz:	Grand Canyon Pk.[a]	7	10.3	1.1	3.7
	Maricopa County[a]	7	9.6	0.9	3.1
	Phoenix	7	9.0	0.8	2.9
	Tucson	6	7.2	0.7	2.6
Ark:	Little Rock	5	7.9	2.3	4.5
	Montgomery Co.[a]	7	4.3	2.0	3.3
Calif:	Berkeley	6	3.8	1.6	3.0
	Glendale	7	6.7	1.6	3.7
	Humboldt County[a]	5	4.5	0.3	2.3
	Long Beach	5	8.2	2.0	4.3
	Los Angeles	7	7.9	2.7	4.1
	Monterey	6	4.5	1.7	3.1
	Oakland	7	5.1	1.4	3.5
	San Bernardino	5	9.9	2.4	5.8
	San Diego	7	9.2	2.1	4.6
	San Francisco	7	3.9	1.6	3.0
	San Jose	6	4.8	2.1	3.3
	Santa Barbara	7	7.7	2.3	3.8
	Stockton	7	10.8	1.8	5.2
Colo:	Denver	7	10.0	1.8	4.6
	Montezuma County[a]	7	5.0	1.1	3.0
	Pueblo	6	7.0	2.5	4.3
Conn:	Hartford	7	7.8	0.8	4.4
	New Britain	7	7.3	0.8	4.2
	New Haven	7	5.5	1.4	3.2
	Norwich	7	10.2	1.0	5.5
	Waterbury	6	7.2	0.7	3.7
Del:	Kent County[a]	4	7.4	2.3	5.0
	Wilmington	6	8.8	1.5	4.5
D.C:	Washington	6	7.7	2.6	4.9
Fla:	Florida Keys[a]	7	9.6	0.4	4.8
	Miami	5	8.5	1.2	4.4
	Orlando	6	4.4	0.4	3.1
	St. Petersburg	7	6.3	1.0	4.1
	Tampa	6	6.2	0.7	3.9
Ga:	Atlanta	6	4.4	0.1	2.7
	Augusta	7	4.6	3.2	3.7
	Savannah	7	4.6	0.7	3.3
Hawaii:	Honolulu	7	3.3	1.8	2.5
	Kahaluu[a]	7	4.5	1.4	2.9
Idaho:	Boise	5	18.2	3.6	9.8
	Butte County[a]	7	18.9	2.1	10.7
Ill:	Chicago	5	6.6	1.5	4.4
	East St. Louis	7	28.5	1.8	8.3
	Joliet	7	9.5	2.3	5.3
	North Chicago	6	12.4	1.6	7.7
	Rockford	7	10.6	2.2	6.3
Ind:	East Chicago	6	10.0	1.3	4.1
	Hammond	7	9.8	1.9	5.6
	Indianapolis	6	12.1	2.5	6.4
	Muncie	7	11.9	2.9	5.3
	Parke County[a]	6	11.4	1.1	5.3
	South Bend	7	11.7	1.9	5.8
	Terre Haute	6	11.3	2.4	6.7
Iowa:	Cedar Rapids	7	9.0	2.6	5.7
	Davenport	7	6.6	1.0	3.2
	Delaware County[a]	7	8.5	2.0	5.6
	Des Moines	7	7.8	1.6	4.9
Kans:	Topeka	7	7.6	1.5	3.7
	Wichita	7	8.7	1.7	4.2
Ky:	Lexington	7	13.8	1.5	5.1
	Louisville	4	11.2	2.9	5.4
La:	New Orleans	6	5.0	1.8	3.4
	Shreveport	6	11.1	1.5	4.1
Maine:	Acadia Nat'l. Park[a]	6	12.0	1.9	4.2
	Portland	6	6.5	1.5	3.1
Md:	Baltimore	7	9.3	2.6	4.8
	Calvert County[a]	7	14.6	3.0	5.8
	Cumberland	7	9.9	2.2	4.9
Mass:	Boston	6	13.2	0.7	5.3
	Lowell	7	16.5	1.4	7.4
	Worcester	7	9.2	0.6	4.9
Mich:	Dearborn	6	11.8	2.0	6.6
	Detroit	7	10.6	1.0	5.2
	Flint	6	17.8	1.6	6.8
	Grand Rapids	6	10.6	2.2	5.8
	Jackson	7	13.6	1.5	5.9
	Muskegon	7	8.7	1.4	4.7
Minn:	Duluth	7	8.1	0.9	5.0
	Minneapolis	7	9.7	1.0	5.2
	St. Paul	7	11.5	1.3	6.1
Miss:	Jackson	5	8.6	2.7	5.3
	Jackson County[a]	6	10.7	1.1	4.0
Mo:	Kansas City	6	9.2	0.7	4.8
	Shannon County[a]	5	9.1	1.3	4.0
	St. Louis	6	8.6	2.6	5.1
Mont:	Glacier Nat'l. Park[a]	6	10.0	2.4	5.8
	Helena	7	13.2	2.9	7.7
Nebr:	Omaha	6	13.3	2.6	6.4
	Thomas County[a]	7	13.3	1.5	5.8
Nev:	Las Vegas	6	8.7	1.0	4.0
	Reno	7	14.6	1.6	9.0
	White Pine County[a]	5	8.8	1.1	3.7
N.H:	Coos County[a]	4	13.1	3.4	9.5
N.J:	Atlantic City	7	9.6	2.1	4.9
	Bayonne	6	8.7	2.3	4.3
	Hamilton	6	9.3	2.7	5.1
	Jersey City	7	4.7	2.6	3.4
	Newark	7	9.3	2.2	4.1
	Paterson	6	8.3	2.2	4.3
N. Mex:	Albuquerque	6	4.1	0.8	2.5
	Colfax County[a]	5	4.6	1.3	2.7
N.Y:	Cape Vincent[a]	7	11.3	1.0	4.7
	Massena	7	13.1	1.1	5.2
	New York	7	7.6	2.4	4.5
	Niagara Falls	7	10.7	1.1	5.1
	Rochester	7	10.4	1.0	4.5
	Troy	4	1.8	0.2	1.1
N.C:	Cape Hatteras[a]	6	8.8	1.7	4.9
	Charlotte	7	8.4	3.5	5.7
	Durham	7	13.8	0.4	5.1
	Greensboro	7	10.4	1.8	5.1
	Raleigh	6	9.7	1.5	4.3
N. Dak:	Bismarck	7	10.8	1.9	5.9
	Ward County[a]	6	11.4	1.3	5.9
Ohio:	Akron	7	10.3	1.1	5.2
	Canton	7	10.9	1.3	5.9
	Cincinnati	7	13.1	1.9	6.0
	Cleveland	6	10.0	1.7	5.2
	Columbus	7	11.2	2.2	5.4
	Dayton	7	12.2	2.5	6.0
	Hamilton	7	13.3	2.3	6.0
	Toledo	7	12.0	1.6	5.5
	Youngstown	7	10.3	1.3	5.1
Okla:	Cherokee County[a]	6	5.7	2.2	3.5
	Oklahoma City	6	6.9	1.9	3.9
	Tulsa	7	11.1	1.6	4.1
Ore:	Curry County[a]	7	5.2	0.5	2.0
	Eugene	5	5.1	1.4	3.1
	Medford	6	5.6	2.2	3.6
	Portland	4	5.5	1.0	2.9
Pa:	Allentown	6	5.6	1.6	3.5
	Altoona	6	11.7	2.8	5.8
	Bethlehem	7	9.7	3.6	7.4
	Clarion County[a]	6	8.1	2.0	4.7
	Erie	6	9.5	3.1	5.2
	Johnstown	6	8.6	2.1	5.7
	Philadelphia	6	8.5	1.6	5.0
	Pittsburgh	7	11.1	2.1	5.7
	Scranton	7	6.7	1.3	3.8
	York	7	12.3	2.7	6.8
R.I:	East Providence	6	8.6	1.8	5.1
	Providence	5	9.2	2.7	5.3
	Washington Co.[a]	7	8.1	1.0	4.7
S.C:	Charleston	6	10.2	2.1	5.9
	Columbia	6	5.4	1.3	3.5
	Richland County[a]	5	8.9	2.3	5.3
S. Dak.	Black Hills[a]	6	12.4	2.5	6.7
	Sioux Falls	7	11.5	1.4	5.6
Tenn:	Chattanooga	7	8.3	2.2	4.5
	Knoxville	7	7.1	1.6	4.3
	Memphis	6	6.6	1.5	4.2
	Nashville	7	8.6	1.5	4.3
Tex:	Aransas County[a]	6	3.9	1.1	2.6
	Austin	7	5.0	1.9	3.2
	Beaumont	6	8.9	1.1	4.1
	Dallas	6	7.0	1.1	3.7
	Galveston	7	4.5	1.2	2.8
	Houston	5	5.1	2.0	3.8
	Odessa	6	4.6	1.6	3.2
	San Antonio	4	4.9	2.2	3.0
	Tyler	7	7.6	2.5	3.8
Utah:	Salt Lake City	6	10.1	1.4	4.1
Vt:	Burlington	4	8.7	0.1	3.6
	Orange County[a]	7	13.1	1.5	4.5
Va:	Hampton	7	9.7	1.2	4.2
	Lynchburg	6	6.4	3.4	4.4
	Norfolk	6	6.8	2.5	4.5
	Portsmouth	7	8.5	2.3	4.1
	Richmond	6	5.4	1.8	4.1
	Roanoke	5	12.3	2.1	6.1
	Shenandoah Park[a]	7	10.8	1.7	5.4
Wash:	Clallam County[a]	4	6.8	2.4	4.5
	Seattle	7	3.0	0.7	2.2
	Spokane	7	11.2	2.9	5.8
W. Va:	Charleston	7	8.9	1.1	4.4
	Wheeling	4	14.6	1.4	9.6
Wis:	Door County[a]	5	10.4	2.3	7.2
	Kenosha	7	9.8	1.5	5.4
	Madison	7	9.8	1.6	5.9
	Milwaukee	7	11.1	1.1	5.9
Wyo:	Cheyenne	7	10.0	2.0	5.1
	Yellowstone Park[a]	7	17.4	1.9	8.4
Network summary		1,194	28.5	0.1	4.8

[a] Nonurban station.

TABLE 4.—FISSION PRODUCT BETA ACTIVITY IN PRECIPITATION—NASN, THIRD QUARTER 1963

Station		July		August		September	
		pc/liter	nc/m²	pc/liter	nc/m²	pc/liter	nc/m²
Ala:	Montgomery	1090	88	—	—	180	12
Fla:	Tampa	550	75	500	32	130	11
Ill:	Chicago (Midway)	600	81	1000	60	780	33
	Chicago (O'Hare)	330	32	—	—	250	17
La:	Lake Charles	650	77	550	25	140	25
Maine:	Caribou	1240	113	680	97	380	26
Mass:	Nantucket	940	57	670	76	220	34
Mich:	Sault Ste. Marie	1720	83	1220	126	330	23
Minn:	St. Cloud	430	22	720	104	290	25
Mo:	Columbia	610	44	420	44	—	—
Mont:	Glasgow	—	—	760	46	—	—
Nebr:	Grand Island	350	24	580	49	—	—
N. Y:	Albany	—	—	1850	88	190	12
N. C:	Hatteras	1550	67	620	33	210	10
Ohio:	Cincinnati (Airport)	580	54	—	—	—	—
	Cincinnati (Gest St.)	—	—	940	64	—	—
Pa:	Philadelphia	2610	167	910	70	340	54
	Charleston	720	131	740	109	340	19
	Greenville	840	52	—	—	60	7
Tenn:	Nashville	550	55	320	50	180	15
Tex:	Amarillo	—	—	250	18	—	—
	Brownsville	—	—	—	—	190	17
Va:	Sterling	—	—	530	64	150	11
Wash:	Tatoosh	2520	113	—	—	—	—

search Station in Cincinnati, Ohio, and the National Air Sampling Network. Monthly composite samples of precipitation are collected at 29 stations, which are located at Weather Bureau offices or airports. They are then forwarded to the network laboratory for analysis.

The laboratory analyzes these samples for total solids and for a large number of metals and nonmetals. In addition, each sample is analyzed for fission product gross beta radioactivity if a sufficient volume of precipitation remains after chemical analyses have been made. Precipitation data for the third quarter 1963 are presented in table 4.

3. CANADIAN AIR MONITORING PROGRAM,[1] SEPTEMBER 1963

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program, the Radiation Protection Division of the Canadian Department of National Health and Welfare monitors air and precipitation. Twenty-four RFSP collection stations are located at airports (see figure 4) where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*3–7*).

Air

Each air sample involves the collection of particulates from about 650 cubic meters of air drawn through a high-efficiency 4-inch-diameter filter during a 24-hour period. These filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. At the laboratory, a 2-inch-diameter disk is cut from each filter and counted with a thin-end-window, gas flow Geiger-Mueller counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are made on each filter to permit correction for natural activities and for the decay of shortlived fission products. The results are extrapolated to the end of the sampling period. Canadian air data for September 1963 are given in table 5 and presented in conjunction with U. S. and Mexican air data by an isogram map (figure 6).

[1] Data from *Radiation Protection Programs*, Vol. 1, No. 10:25–31, Radiation Protection Division, Canadian Department of National Health and Welfare, (October 1963).

TABLE 5.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR, CANADA, SEPTEMBER 1963

[Concentrations in pc/m³]

Station	Number of samples	Maximum	Minimum	Average
Calgary	29	4.3	0.1	2.5
Coral Harbour	30	4.4	0.1	1.2
Edmonton	30	3.8	0.1	2.0
Ft. Churchill	29	3.6	0.2	1.6
Ft. William	30	4.9	0.1	1.9
Fredericton	30	4.7	0.1	2.2
Goose Bay	29	4.6	0.1	2.0
Halifax	25	5.7	0.0	2.4
Inuvik	30	4.6	0.4	1.9
Montreal	29	6.7	0.7	3.3
Moosonee	30	8.1	0.2	2.2
Ottawa	29	5.5	0.4	3.2
Quebec	29	5.1	0.6	2.7
Regina	30	8.0	0.1	2.3
Resolute	30	3.8	0.2	1.2
St. John's, Nfld	29	3.8	0.2	1.9
Saskatoon	30	6.4	0.1	2.3
Sault Ste. Marie	30	5.9	0.1	2.5
Toronto	29	3.6	0.5	1.4
Vancouver	29	3.5	0.8	1.7
Whitehorse	30	5.3	0.1	1.2
Windsor	30	6.2	0.8	3.1
Winnipeg	30	5.2	0.1	2.0
Yellowknife	30	4.8	0.1	1.7
Network summary	706	8.1	0.0	2.1

Precipitation

The amount of radioactive fallout deposited on the ground is determined from measurements on material collected in special polyethylene-lined rainfall pots. The collection period for each sample is one month. After transfer of the water to the sample container the polythylene liner is removed, packed with the sample, and sent to the laboratory. Gross beta in precipitation for stations in Canada are presented in table 6. Radionuclide analyses of these samples are given in table 1, page 17.

TABLE 6.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, CANADA SEPTEMBER 1963

Station	Total beta activity	
	pc/liter	nc/m²
Calgary	465	23.5
Coral Harbour	1203	31.8
Edmonton	878	29.4
Ft. Churchill	880	76.6
Ft. William	1150	76.8
Fredericton	405	50.6
Goose Bay	690	75.8
Halifax	243	44.0
Inuvik	4375	14.4
Montreal	761	89.6
Moosonee	1187	68.1
Ottawa	736	84.3
Quebec	600	75.5
Regina	1708	29.5
Resolute	442	37.0
St. John's, Nfld.	539	60.3
Saskatoon	1592	52.1
Sault Ste. Marie	657	48.2
Toronto	1153	30.5
Vancouver	1620	62.1
Whitehorse	674	43.5
Windsor	674	28.9
Winnepeg	3235	51.7
Yellowknife	1644	34.6
Average	1146	50.8

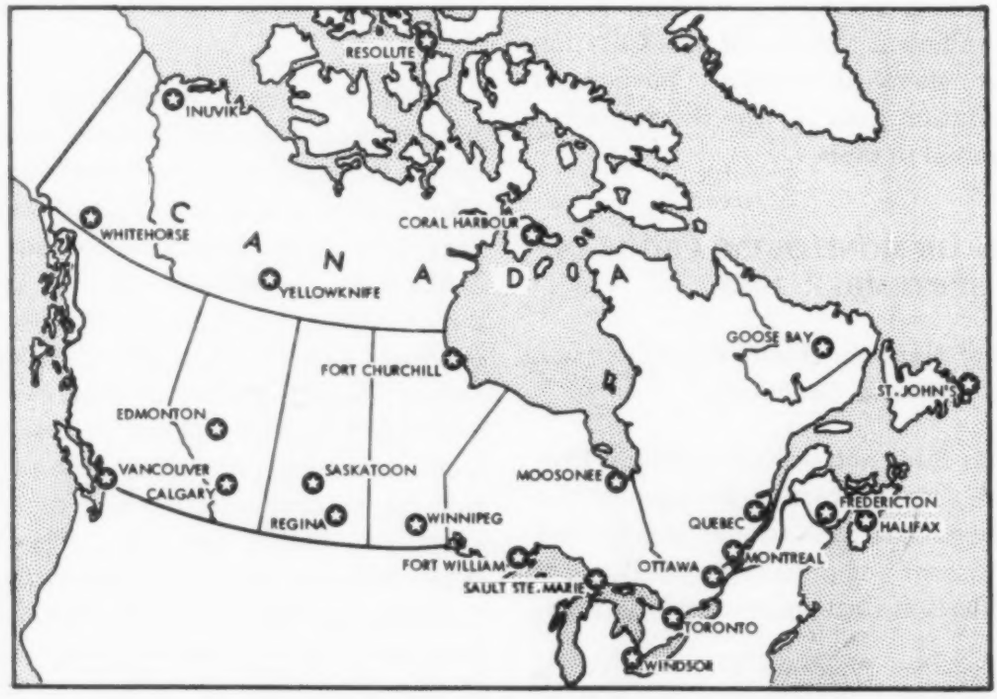

FIGURE 4.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS, SEPTEMBER 1963

4. MEXICAN AIR MONITORING PROGRAM, SEPTEMBER 1963

National Commission of Nuclear Energy

The Radiation Surveillance Network of Mexico was established by the Comision Nacional de Energia Nuclear (CNEN) through its Radiological Protection Program (RPP) in 1961 to provide a means for determining increased levels of radioactivity in air and precipitation.

Prior to the establishment of the network, two pilot sampling stations were set up (in Mexico City and San Luis Potosí) to aid in the selection of equipment and sampling sites. Since April 1962 the network has been gradually expanded to 17 stations with the recent addition of stations at Guaymas and Mazatlan (see figure 5). Twelve of the 17 stations are located at airports and operated by airline personnel. The remaining five stations are located at Mexico City, Mérida, Veracruz, San Luis Potosí and Ensenada. Staff members of the RPP operate the station at Mexico City while the other four stations are manned by members of the Centro de Prevision del Golfo de Mexico, the Chemistry Department of the University of Mérida, the Instituto de Zonas Deserticas of the University of San Luis Potosí, and the Escuela Superior de Ciencias Marinas of the University of Baja California, respectively.

The sampling procedure involves drawing air for 24 hours a day, 3 or 4 days a week, at the rate of approximately 1,200 cubic meters per day, through a high-efficiency, 6 × 8 inch glass fiber filter, using high volume samplers. After each 24-hour period, the filter is removed and forwarded via air mail to the "Laboratorio de Estudios Sobre Contaminación Radiactiva," CNEN, in Mexico City for assay of gross beta activity. A minimum of 3 or 4 days after collection is allowed for decay of radon and thoron daughter natural radioactivity. Data are not extrapolated to time of collection.

The maximum, minimum and average fission product beta concentrations in surface air during September are presented in table 7.

TABLE 7.—GROSS BETA ACTIVITY OF AIRBORNE PARTICULATES, MEXICO, SEPTEMBER 1963

[Concentrations in pc/m³]

Station	Number of Samples	Maximum	Minimum	Average
Acapulco	6	0.2	0.1	0.2
Ciudad Juárez	15	2.0	0.3	0.8
Chihuahua	10	3.5	0.1	0.9
Ensenada	10	3.1	1.1	1.7
Guadalajara	9	1.0	0.2	0.4
Guaymas	21	3.6	0.4	1.4
La Paz	11	3.4	0.5	1.6
Matamoros	16	2.6	0.1	1.1
Mazátlan	15	1.1	0.2	0.5
Mérida	6	1.8	0.2	0.7
México, D. F.[a]	19	1.7	0.1	0.5
Nuevo Laredo	8	2.4	1.0	1.7
San Luis Potosí	13	3.6	0.4	1.6
Tampico	15	3.7	0.2	1.3
Torreón	12	3.8	0.6	1.7
Tuxtla Gutiérrez[b]	0			
Veracruz	19	2.3	0.2	0.7
Network summary	205	3.8	0.1	1.0

[a] Mexico City
[b] Temporarily shut down

FIGURE 5.—FALLOUT NETWORK SAMPLING STATIONS IN MEXICO

5. PAN AMERICAN AIR SAMPLING PROGRAM, SEPTEMBER 1963

Pan American Health Organization and Public Health Service

Gross beta activity in air is monitored by three countries in South America under the auspices of a collaborative program developed by the Pan American Health Organization and the Public Health Service (PHS) for assisting countries of the Americas to develop their own radiological health programs. The sampling equipment and analytical services are provided by the Division of Radiological Health, PHS, and are identical with those employed for the Radiation Surveillance Network.

The three air sampling stations included in the program are operated by the technical staff of the Ministry of Health in each country. The station in Santiago, Chile is operated by the Occupational Health Service; in Lima, Peru by the Institute of Occupational Health; and in Venezuela by the Venezuelan Institute for Scientific Investigations. The Caracas station was activated in November 1962 and the other two stations began air monitoring in December of the same year.

The September 1963 air monitoring results from the three participating countries are given in table 8. The Caracas station is shown on the gross beta concentration isogram map (figure 6). The average concentration at this station adjusted by the RSN intercalibration factor of 1.28 is <0.17 pc/m^3, considerably below the lowest isogram line used on the map (1 pc/m^3).

TABLE 8.—GROSS BETA ACTIVITY IN AIR, SEPTEMBER 1963

[Concentrations in pc/m^3]

Sampling Stations	No. of samples	Maximum	Minimum	Average[a]
Caracas, Venezuela	21	0.29	<0.10	<0.13
Lima, Peru	13	0.19	<0.10	<0.11
Santiago, Chile	12	0.43	<0.10	<0.19

[a] The monthly average is calculated by weighting the individual samples with lengths of sampling period. Values of <0.10 are assumed to be 0.10 for averaging purposes. If the <0.10 values represent more than 10% of the average, a less-than sign is placed in front of the average.

6. GROSS BETA ACTIVITY IN AIR, NORTH AMERICA, SEPTEMBER 1963

Beginning with January 1963 data, monthly average concentrations of airborne gross beta activity in Canada and the United States have been presented in combined form as isogram maps of most of North America.[1] The data from the Radiation Surveillance Network and the Canadian Air Network were adjusted to each other by means of an intercalibration factor derived by Lockhart and Patterson (*8*).

With the formation of the Mexican Air monitoring program, new intercalibration ratios were determined, this time including the Canadian Network, Radiation Surveillance Network, National Air Sampling Network, the new 80th Meridian Network, and the Mexican Network. The results of this filter study have been published elsewhere (*9*) and are summarized on pages 12–15. The new intercalibration reflects changes in standardization in both the RSN and the Canadian Air Network, effective September 1963. The intercalibration factors are therefore not the same as were previously used.

Figure 6 shows the average gross beta activity in air throughout North America for September 1963. Based on the new intercalibration and setting the Canadian factor at 1.00, the Mexican data were multiplied by 0.81 and the RSN data were adjusted by a factor of 1.28.

[1] The January to August 1963 isogram maps were published in the May to December 1963 *Radiological Health Data*, respectively.

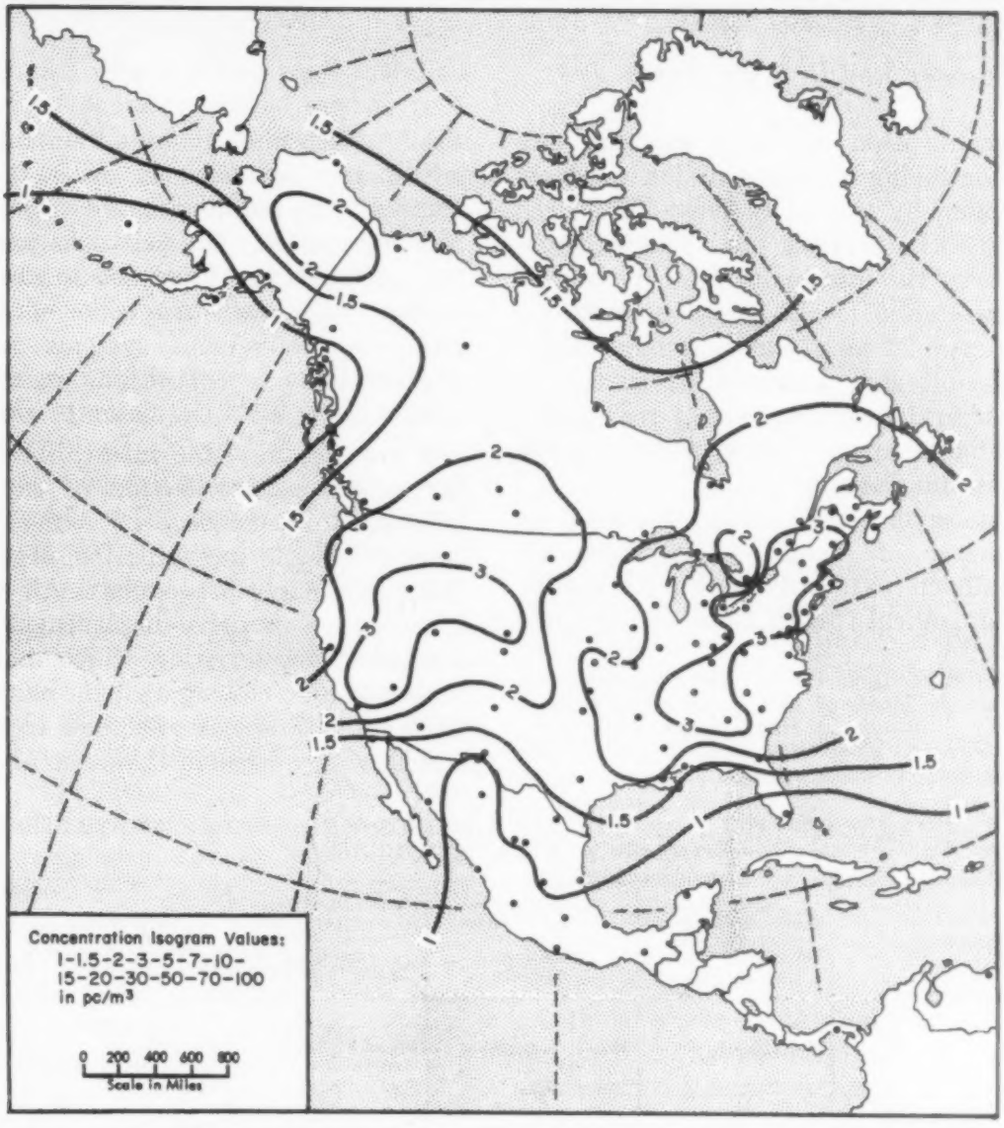

FIGURE 6.—ISOGRAMS OF AVERAGE GROSS BETA CONCENTRATIONS IN AIR THROUGHOUT NORTH AMERICA, SEPTEMBER 1963

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Intercalibration of The Major North American Air Monitoring Systems[1]

L. B. Lockhart, Jr. and R. L. Patterson, Jr.[2]

An intercalibration of some systems employed in monitoring airborne fission products was undertaken by the U. S. Naval Research Laboratory (NRL) in 1962 (*1*). The information supplied by this intercalibration proved of utility to the Public Health Service in its reporting and correlating of data supplied by the various air monitoring networks. In particular it made possible the construction of reasonably accurate contour maps of radioactivity over the United States and Canada.

At the request of the Comision Nacional de Energia Nuclear of Mexico (Laboratorio de Desechos Radiactivos) and the Public Health Service (Radiological Health Data and Reports Staff), NRL undertook another intercalibration which was extended to cover the five major radioactivity monitoring networks operating in North America. The networks participating in this program are identified in table 1; also included in this table are some of the characteristics of the various systems used by these organizations to collect and measure the concentration of airborne fisson products.

Fundamentally, the intercalibration involved the side-by-side collection of samples at this laboratory for subsequent evaluation of radioactivity by the participating organizations by their customary procedures. All samples were collected on positive-displacement blowers of similar characteristics which had been calibrated for air flow against the same flow meter. Each filter thus was presumed to have sampled a measured volume of the same air mass.

[1] Summary of NRL Report 6025, see reference (*2*).

[2] Dr. Lockhart is Head of the Physical Chemistry Branch, and Mr. Patterson is Head of the Radiochemistry Section, Physical Chemistry Branch, U.S. Naval Research Laboratory, Washington, D.C.

TABLE 1.—CHARACTERISTICS OF THE AIR MONITORING SYSTEMS COMPARED IN THE INTERCALIBRATION PROGRAM

System Elements	Radiological Protection Program, National Commission of Nuclear Energy, Mexico	Radiation Protection Division, Canadian Dept. of Health and Welfare	80th Meridian (West) Sampling Program, USAEC, Health and Safety Laboratory	National Air Sampling Network, Public Health Service	Radiation Surveillance Network, Public Health Service
Air Sampler					
Blower type	Centrifugal	Positive displacement	Positive displacement	Centrifugal	Centrifugal
capacity[a]	1800-2000 m^3/day (STP)	650 m^3/day	1200 m^3/day	2200 m^3/day	2000 m^3/day
Motor, type	Free-running	Constant speed	Constant speed	Free-running	Free-running
Filter, type	Glass fiber	Glass fiber	Polystyrene	Glass fiber	Cellulose, carbon loaded
designation	Staplex TFA-69 GF	Hurlburt 934AH	Microsorban	MSA-1106BH	MSA BM-2133 (CR-17651)
size	6 x 9 inches	4 inch dia.	8 inch dia.	8 x 10 inches	4 inch dia.
effective area	41.3 sq. inches	9.3 sq. inches	41.7 sq. in.	63.0 sq. in.	9.6 sq. in.
Volume measurement (at field stations)	Orifice plate and gage	Prior calibration	Pressure gage and prior calibration	Orifice plate and gage	Orifice plate and gage
Sample processing	1⅛″ disc removed for counting	2″ disc removed for counting	γ-counted in plastic envelope	Effective area counted 41.9 sq. in.	Counted in glassine envelope
Counting procedure					
Counter, type-size (dia.)	Gas flow Geiger-Mueller	Gas flow Geiger-Mueller-2 inch	10 x 20 cm NaI crystal	Gas flow proportional-7½ in.	Gas flow proportional-7½ in.
window thickness	0.15 mg/cm^2	0.8 mg/cm^2	(not applicable)	0.9 mg/cm^2	4.5 mg/cm^2
geometry	2π	2π	2π	2π	2π
background	2 c/m	13 c/m	1000 c/m	300 c/m	500 c/m
Counting time	Preset count of 1000 or 2000	Preset count of 1000	10 or 20 min.	1 or 2 min.	1 min.
Standard	Tl^{204}	Sr^{90} (Y^{90})	Cs^{137}, Ce^{144}, I^{131}, Zr^{95}, Ba^{140}	RaD+E, Tl^{204}	Sr^{90} (Y^{90})
Activity recorded	At time of measurement (4-7 days after collection)	Extrapolated to end of collection	At time of measurement; β activity estimated from counts of γ (>1 mev) and γ (total).	Extrapolated to end of collection	Extrapolated to end of collection.

[a] Average capacity in operating system

Experimental Procedures

The five air sampling systems were installed in three louvered shelters located on the roof of a building at NRL some 25 feet above the ground. Each of the sampler units employed a filter head either supplied by the participating network or similar to that used by the network. The filter media used in this study were also supplied by the networks from their usual stocks.

Samples were routinely collected over a 24-hour period starting at 3:00 PM (1500) local time, except on weekends when 72-hour collections were made. The sampling phase of this program covered the period May 31–June 24, 1963, a time when there was considerable long-lived fission product radioactivity in the air.

On removal of samples from the collectors, two or more of them were placed in lead-shielded Geiger-Mueller counters and their β-activity followed for a period of 16 hours. Subsequently, the remaining samples were counted and all corrected for the residual natural activity remaining, as estimated from the decay measurements. Counting was performed with the samples enclosed in glassine or plastic envelopes to prevent contamination or loss of activity from the filter by handling. The samples were then forwarded to the parent organizations for measurement.

Results

The preliminary measurements were undertaken at NRL to ascertain if the various samples were truly duplicates. The summary of these measurements in terms of the ratios of activity found on the various filters presented in table 2 indicates that the samples from certain units were biased to some extent; the small variations of single pairs of measurements, however, indicate that each collector was effectively sampling the same air mass. The observed bias appears to be related to filter behavior rather than to the local sampling arrangement, though small differences could be caused by absorption of β activity by the envelopes in which the samples were counted. The Public Health Service Radiation Surveillance Network cellulose filter has been noted previously to be less effective due to lower filter efficiency and greater self-absorption of activity (*1*); the Health and Safety Laboratory filters had visibly uneven deposit of dust and a measurable difference in radioactivity across the surface. Since in these preliminary evaluations only a single measurement was made of a small area in the approximate center of the filter, any persistent variation in activity with location could introduce bias into the results.

TABLE 2.—RELATIVE ACTIVITY OF FILTERS FROM PRELIMINARY EVALUATION AT NRL[a]

Systems Compared	Number of Measurements	Mean of Measured Ratios	Standard Deviation	
			of Mean	of Single Measurement
Relative to PHS-RSN				
Mexico	16	1.26	±0.019	±0.075 (6.0%)
Canada	11	1.22	±0.016	±0.054 (4.4%)
HASL	16	1.09	±0.023	±0.091 (8.3%)
PHS-NASN	16	1.32	±0.019	±0.078 (5.9%)
Relative to PHS-NASN				
Mexico	16	0.95	±0.016	±0.063 (6.6%)
Canada	11	0.91	±0.013	±0.044 (4.9%)
HASL	16	0.83	±0.012	±0.049 (5.9%)
Relative to HASL				
Mexico	16	1.16	±0.026	±0.104 (9.0%)
Canada	11	1.10	±0.021	±0.070 (6.5%)
Mexico/Canada	11	1.03	±0.014	±0.048 (4.6%)

[a] Corrected for relative filter areas.

The fission product radioactivity concentrations reported by the participating organizations for these duplicate samples are reported in table 3. In each case the volume of air sampled is based on the NRL measurement. The ratios of the activity concentrations of samples collected during the same period and evaluated by the different methods are listed in table 4 together with the average ratios and their standard deviations. These ratios are the factors for converting radioactivity concentrations determined by any one system to those of another system. It should be pointed out that these factors do not take into account possible discrepancies in the determination or estimation of the volume of air sampled at the various field installations; moreover, they are based on the counting of samples of old fission debris (minimum age of 5 months), whose β energy distribution is different from that of fresh fission products.

No data have been included for the Canadian filters during the period May 31–June 7 because of a lack of knowledge of the volume of air sampled (which resulted from a slipping V-belt drive on the blower), or for the Mexican filters

TABLE 3.—AIR CONCENTRATIONS OF FISSION PRODUCT RADIOACTIVITY BASED ON ANALYSIS BY THE PARENT ORGANIZATION OF AIR FILTERS EXPOSED IN PARALLEL AT WASHINGTON, D.C.

Collection period (1963)	Activity in picocuries per cubic meter of air				
	Mexico	Canada[1, 2]	PHS–RSN[1]	PHS–NASN[1]	HASL
May 31–June 3	7.23	—	4.58	7.8	5.99
June 3–4	1.45	—	0.82	1.36	0.96
4–5	10.30	—	7.74	13.0	9.32
5–6	7.32	—	4.73	8.1	5.49
6–7	9.63	—	6.08	10.7	7.38
June 7–10	5.73	4.14	3.72	6.6	4.86
10–11	16.10	12.83	10.11	19.4	14.27
11–12	11.84	8.64	7.29	13.7	9.86
12–13	7.02	5.09	4.33	7.9	5.81
13–14	—	11.52	8.01	13.5	9.32
June 14–17	—	7.97	8.34	14.9	11.03
17–18	—	14.40	10.21	18.7	13.77
18–19	—	15.75	10.63	19.5	14.31
19–20	—	11.52	8.57	15.5	12.15
20–21	—	5.72	4.00	6.7	4.86
June 21–24	—	10.89	8.65	15.9	11.70

[1] Activity extrapolated to time of collection.
[2] Based on new standardization effective September 1, 1963.

TABLE 4.—ACTIVITY CONCENTRATION RATIOS OF PARALLEL SAMPLES EVALUATED BY THE VARIOUS PARTICIPATING ORGANIZATIONS

Comparative Radioactivity Results	Number of Measurements	Mean of Measured Ratios	Standard Deviation	
			of Mean	of Single Comparison
I. Relative to PHS–RSN				
a. Mexico	9	1.58	±0.038	±0.114 (7.2%)
b. Canada	11	1.28	±0.049	±0.161 (12.6%)
c. HASL	16	1.29	±0.022	±0.088 (6.8%)
d. PHS–NASN	16	1.77	±0.020	±0.080 (4.5%)
II. Relative to PHS–NASN				
a. Mexico	9	0.89	±0.026	±0.078 (8.8%)
b. Canada	11	0.71	±0.031	±0.104 (14.6%)
c. HASL	16	0.73	±0.007	±0.027 (3.7%)
III. Relative to HASL				
a. Mexico	9	1.24	±0.041	±0.123 (9.9%)
b. Canada	11	0.97	±0.047	±0.155 (16.0%)
IV. Other				
a. Mexico/Canada	4	1.34	±0.032	±0.063 (4.7%)

during the period June 13–24, when their radioactivity counting equipment was malfunctioning. However, sufficient information has been obtained during periods when the fission product concentrations varied widely to give statistically significant intercalibration ratios to the counting techniques employed by the various networks.

The activity concentration ratios shown in table 4 relative to the Public Health Service Radiation Surveillance Network (RSN) are as follows: Canada (effective September 1, 1963), 1.28 ± 0.049; Health and Safety Laboratory (HASL), 1.29 ± 0.022; Mexico, 1.58 ± 0.038; and, Public Health Service National Air Sampling Network (NASN), 1.77 ± 0.020. The Canadian value of 1.28 ± 0.049 would have been 1.64 ± 0.063 by the standardization in effect prior to September 1963; this is in reasonable agreement with the value 1.54 ± 0.021 determined in the 1962 intercalibration (*1*).

These activity ratios may also be expressed relative to any of the other networks. Relative to Canada[1] the ratios are: RSN, 0.78; HASL, 1.01; Mexico, 1.23; and NASN, 1.38.[2]

Conclusions

Interconversion factors for comparing the radioactivity concentrations reported by the major air monitoring networks in North America have been derived which are realistic for the various networks as now operated to the extent that the on-site air flow measurements are themselves realistic. The relative activity concentrations reported by the net-

[1] The values given in *Radiological Health Data*, December 1962 (*1*) were relative to Canada, i.e. setting Canada = 1.00.

[2] Conversion factors, applied to data from the various networks so that they correspond to the Canadian data, are found by taking the reciprocals of the activity ratios. They are as follows: RSN, 1.28; HASL, 0.99; Mexico, 0.81; and NASN, 0.72.

works are as follows: Public Health Service Radiation Surveillance Network, 0.78; Canadian Radiation Protection Division Network, 1.00; USAEC Health and Safety Laboratory 80th Meridian Network, 1.01; Mexican Radiological Protection Program Network, 1.23; and Public Health Service National Air Sampling Network, 1.38.

The above factors apply accurately only to a fission product conglomerate which is relatively free of the shorter-lived fission products. The minimum age of any debris that could have been collected during the period of this intercalibration (May 31–June 24) was over five months; however, the average age was considerably longer because of the large quantity of older bomb debris that existed in the stratospheric source of fallout at this time. The β energy distribution of the gross fission products which one might expect to collect in the future in the absence of further atmospheric contamination by nuclear explosions should not be significantly different from that existing at the time of this study.

Acknowledgments

The U. S. Naval Research Laboratory and the authors wish to express their appreciation to the various organizations and persons who have cooperated in this project: Ing. A. P. Baez, Subdirector, Radiological Protection Program, National Commission of Nuclear Energy, Mexico; Dr. A. H. Booth, Senior Scientific Officer, Radiation Protection Division, Department of National Health and Welfare, Canada; Dr. J. H. Harley, Director, and Mr. W. R. Collins, Health and Safety Laboratory, U. S. Atomic Energy Commission; Mr. E. C. Tabor, Chief, Air Quality Section, Division of Air Pollution, Public Health Service; and Mr. D. L. Snow, Chief, and Mr. R. G. Bostrom, Radiological Health Data and Reports Staff, and Mr. C. A. Markarian, Chief, State Surveillance Program, Division of Radiological Health, Public Health Service. Partial financial support was supplied by the Division of Biology and Medicine. U. S. Atomic Energy Commission.

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(*2*) Lockhart, L. B. Jr., and R. L. Patterson, Jr.: *Intercalibration of the Major North American Networks Employed in Monitoring Airborne Fission Products, NRL Report 6025*, Naval Research Laboratory, Washington, D.C. 20390 (December 1963).

Fission Product Gamma Activity in Airborne Particulates— 80th Meridian, August 1963

Health and Safety Laboratory, AEC

Total gamma activity measurements for weekly ground-level air filter samples taken at 80th Meridian stations (see figure 1) during August 1963 are listed in table 1. Calculated ratios of gamma activity in excess of 1 Mev to total gamma activity are also listed in the table. Average monthly total gamma activity concentrations calculated from the weekly values are plotted in figure 2 as an activity-latitude profile and compared with the profile for the second quarter 1963 average.

Gamma activity results for August show a general decrease in ground-level air concentrations in the Northern Hemisphere but no major change in the Southern Hemisphere levels with respect to results obtained for July 1963. The data show a shift in the Northern Hemisphere air concentration maximum from about latitude 30° to 50°. The average value for the Northern

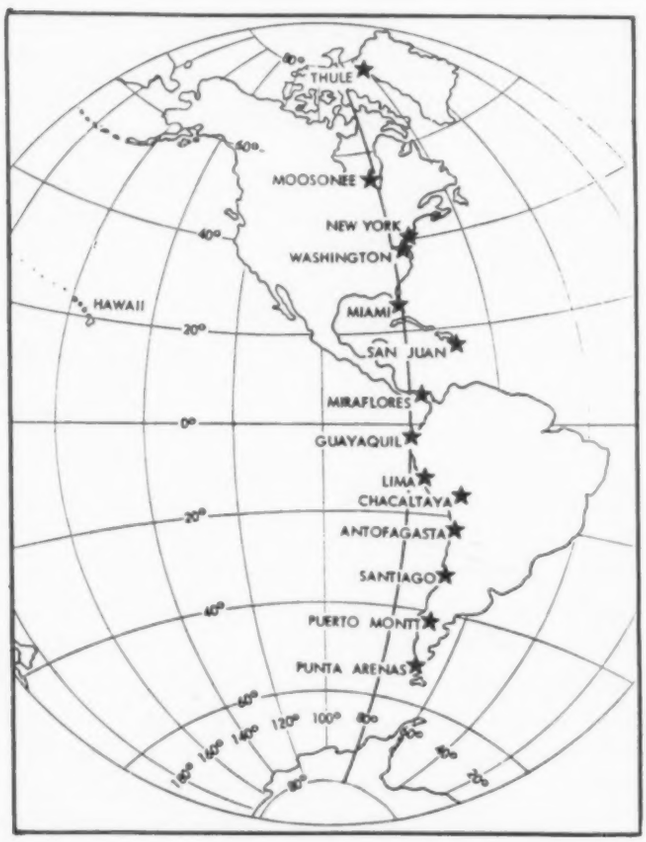

FIGURE 1.—80TH MERIDIAN NETWORK SAMPLING STATIONS

TABLE 1.—ACTIVITY OF SURFACE AIR, 80TH MERIDIAN NETWORK, AUGUST 1963

Sampling station	Sampling period (dates—noon to noon)	Gamma activity (photons/min/m²)		Gamma ratio ($\gamma > 1$ Mev / total γ)
		Filter	Average for month	
Thule	8/1 –8	12.0		0.034
	8/8 –15	1.33		0.034
	8/15–22	2.70		0.035
	8/22–9/1	1.94	4.49	0.035
Moosonee	8/1 –8	4.77		0.054
	8/8 –15	2.14		0.045
	8/15–22	2.22		0.040
	8/22–9/1	1.52	2.66	0.047
New York	8/1 –8	4.14		0.047
	8/8 –15	12.4		0.049
	8/15–22	3.46		0.048
	8/22–9/1	2.54	5.64	0.047
Washington	8/1 –8	5.08		0.035
	8/8 –15	5.46		0.035
	8/15–22	2.49		0.040
	8/22–9/1	2.34	3.84	0.038
Miami	8/1 –8	2.22		0.045
	8/8 –15	1.52		0.039
	8/15–22	0.642		0.047
	8/22–9/1	1.16	1.39	0.039
Mauna Loa	8/1 –8	1.36		0.043
	8/8 –15	0.974		0.044
	8/15–22	1.65		0.045
	8/22–9/1	1.46	1.36	0.048
San Juan	8/1 –8	1.51		0.042
	8/8 –15	0.903		0.038
	8/15–22	0.757		0.036
	8/22–9/1	0.909	1.02	0.046
Miraflores	8/1 –8	0.525		0.049
	8/8 –15	0.616		0.049
	8/15–22	0.491		0.052
	8/22–9/1	0.309	0.485	0.050
Guayaquil	8/1 –8	0.0617		0.043
	8/8 –15	0.0769		0.060
	8/15–22	0.0892		0.052
	8/22–9/1	0.0894	0.0793	0.047
Lima	8/1 –8	0.0697		0.022
	8/8 –15	0.176		0.037
	8/15–22	0.0688		0.031
	8/22–9/1	0.170	0.121	0.045
Chacaltaya	8/1 –8	0.414		0.046
	8/8 –15	0.269		0.041
	8/15–22	0.275		0.050
	8/22–9/1	0.253	0.303	0.043
Antofagasta	8/1 –8	0.0650		0.037
	8/8 –15	0.154		0.048
	8/15–22	0.126		0.053
	8/22–9/1	0.115	0.115	0.048
Santiago	8/1 –8	0.208		0.057
	8/8 –15	0.114		0.043
	8/15–22	0.0825		0.049
	8/22–9/1	0.116	0.130	0.054
Puerto Montt	8/1 –8	0.0303		0.059
	8/8 –15	0.0614		0.039
	8/15–22	0.0299		0.053
	8/22–9/1	0.0348	0.0391	0.054
Punta Arenas	8/1 –8	0.0283		0.050
	8/8 –15	0.0156		0.050
	8/15–22	—		—
	8/22–9/1	0.0277	0.0239	0.040

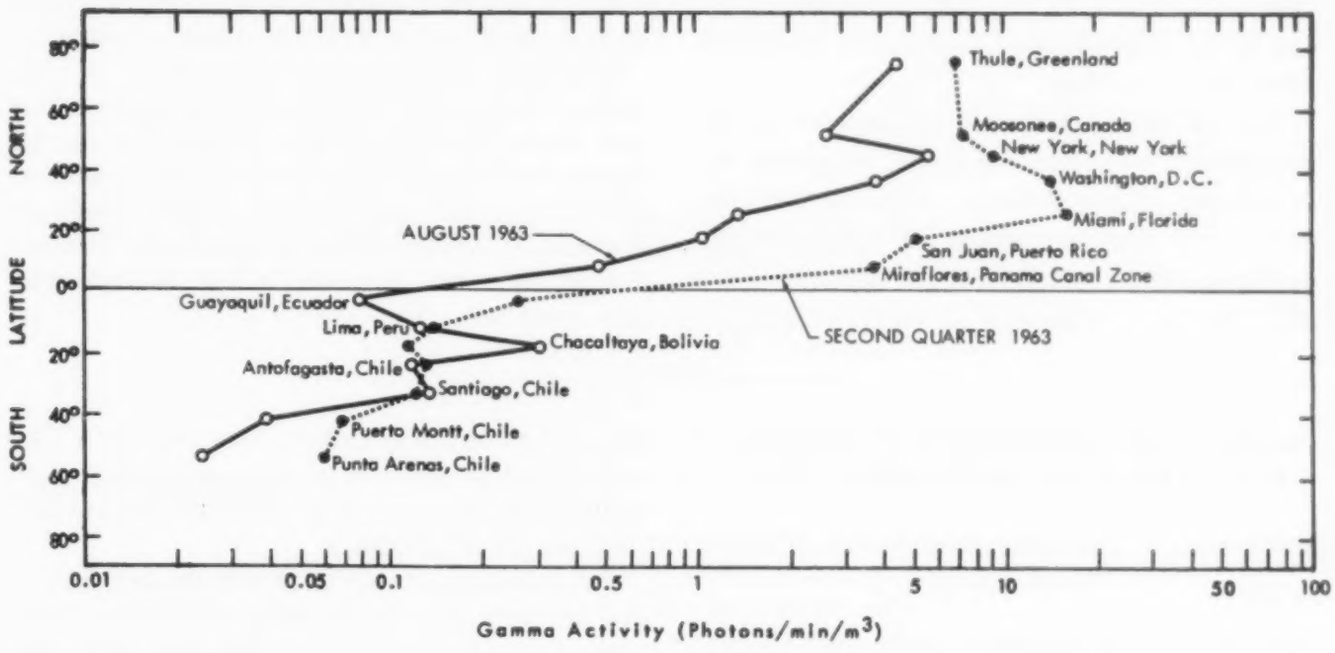

FIGURE 2.—PROFILE OF SURFACE AIR GAMMA ACTIVITY, SECOND QUARTER AND AUGUST 1963

Hemisphere was 2.6 γ/min/m^3 (photons per minute per cubic meter) with a range of from 0.49 to 5.6 γ/min/m^3. At the southern hemisphere stations the average concentration was 0.10, with a range of from 0.024 to 0.30 γ/min/m^3.

Total beta activity estimates are not given for the August samples because of the continued appearance of significant concentrations of non-fission produced high-energy gamma emitters.

Recent coverage in *Radiological Health Data*:

Period	Issue
March, and April 1963	*September 1963*
May 1963	*October 1963*
June, and July 1963	*December 1963*

Monthly Deposition of Various Radionuclides

For the purpose of this section, fallout is defined as the deposition of radioactive materials on the earth's surface.

Total fallout is generally considered to be composed of two fractions: that deposited by the settling of particulates, often termed dry fallout, and that contained in precipitation, sometimes called wet fallout or rainout. Normally, fallout is expressed in terms of the activity of selected radionuclides deposited on a unit surface during a given period of time.

Monthly strontium–90 deposition in the United States and other areas during the first and second halves of 1962, as reported by the Health and Safety Laboratory, AEC, appeared in the August and October 1963 issues of *Radiological Health Data*, respectively. Deposition of other radionuclides at four stations was also reported.

FALLOUT MEASUREMENTS IN CANADA,[1] JULY THROUGH SEPTEMBER 1963

Department of National Health and Welfare
Ottawa, Canada

The monthly accumulated precipitation samples collected in conjunction with the Canadian air sampling network described earlier in this issue represent total fallout (wet and dry). The radiochemical analyses of these precipitation or fallout samples for July through September 1963 are given in table 1.

Radiochemical analyses of fallout samples for five stations for the months of October 1962 through April 1963 were included with the tables of gross beta in precipitation in the February through August 1963 issues of *Radiological Health Data*. May and June radiochemical data for the five stations were reported in the October 1963 *RHD*.

[1] Data from *Radiation Protection Programs*, Vol. 1, No. 8. p 19; No. 9, p 18; No. 10, p 24, Radiation Protection Division, Canadian Department of National Health and Welfare (Aug.–Oct., 1963).

TABLE 1.—ANALYSIS OF FALLOUT FOR SPECIFIC RADIONUCLIDES, JULY–SEPTEMBER 1963[a]

[nc/m²]

Station	Deposition during July					Deposition during August					Deposition during September				
	Sr^{89}	Sr^{90}	Cs^{137}	Zr^{95}	Ba^{140}	Sr^{89}	Sr^{90}	Cs^{137}	Zr^{95}	Ba^{140}	Sr^{89}	Sr^{90}	Cs^{137}	Zr^{95}	Ba^{140}
Calgary	16.4	5.41	11.2	35.8	0.06	3.96	1.87	3.84	12.10	0.94	0.49	0.40	0.84	1.44	0.031
Coral Harbour	5.24	1.59	2.26	[b]—	—	2.29	1.35	2.22	—	—	0.58	0.46	1.04	—	—
Edmonton	3.74	2.15	1.28	—	—	1.32	0.85	2.47	—	—	0.61	0.58	0.89	—	—
Ft. Churchill	6.06	3.52	4.48	—	—	1.13	0.65	1.11	—	—	1.69	1.06	2.12	—	—
Ft. William	5.45	1.97	2.88	—	—	1.99	0.88	3.90	—	—	1.65	1.32	3.24	—	—
Fredericton	5.75	4.05	6.62	—	—	8.16	3.87	6.58	—	—	1.12	0.87	1.72	—	—
Goose Bay	11.0	3.85	6.75	—	—	[c]	[c]	[c]	[c]	[c]	1.95	1.26	2.33	—	—
Halifax	5.76	1.86	3.80	11.2	0.07	6.25	2.36	4.70	12.0	0.03	1.65	1.20	1.92	5.15	0.003
Inuvik	5.14	2.27	4.27	—	—	2.44	0.97	1.51	—	—	0.30	0.27	0.47	—	—
Montreal	[b]—	—	—	—	—	10.7	4.38	8.35	23.2	0.04	2.72	1.97	3.10	2.79	0.044
Moosonee	4.57	4.31	1.11	—	—	3.67	2.07	2.65	—	—	1.40	0.86	1.99	—	—
Ottawa	9.15	2.96	5.53	—	—	5.86	3.65	6.38	—	—	1.95	1.56	2.72	—	—
Quebec	4.22	1.90	3.48	—	—	6.66	3.58	5.74	—	—	1.52	1.08	2.30	—	—
Regina	14.0	4.20	7.87	—	—	4.31	2.82	4.29	—	—	0.54	0.71	0.88	—	—
Resolute	[c]	[c]	[c]	[c]	[c]	0.38	0.74	0.67	—	—	0.41	0.91	1.45	—	—
St. John's, Nfld.	4.63	1.42	2.26	—	—	4.18	2.15	3.69	—	—	0.94	0.60	1.19	—	—
Saskatoon	14.0	5.00	7.80	—	—	4.37	1.86	4.95	—	—	0.88	0.84	1.56	—	—
Sault Ste. Marie	5.60	2.56	4.86	—	—	4.74	2.90	5.35	—	—	1.39	1.01	1.59	—	—
Toronto	6.78	1.58	1.92	—	—	4.78	1.95	2.39	—	—	0.72	0.46	0.89	—	—
Vancouver	6.01	2.04	2.58	9.50	0.05	1.76	0.92	1.72	4.73	0.05	1.18	0.82	1.71	3.88	0.020
Whitehorse	3.02	1.10	2.31	—	—	1.39	1.15	1.98	—	—	1.43	1.06	1.81	—	—
Windsor	3.00	1.68	3.11	—	—	1.80	1.42	1.72	—	—	0.54	0.45	0.44	—	—
Winnipeg	—	—	—	—	—	4.85	2.56	3.26	9.60	0.07	0.92	0.64	1.32	2.42	0.029
Yellowknife	8.16	2.91	2.49	—	—	4.18	1.65	3.00	—	—	0.79	0.77	1.13	—	—

[a] All values corrected for decay back to end of collection month.
Values for Sr^{90}, Cs^{137} and Zr^{95} do not include the activities of their daughter nuclides, Y^{90}, Ba^{137m} and Nb^{95}.
[b] Dash indicates no analysis.
[c] No sample.

SECTION II.—MILK AND FOOD

Milk Surveillance

Although milk is only one of the many sources of dietary intake of radionuclides, it is the single food item most often used as an indicator of the population's intake of radionuclides from the environment. This is because fresh milk is consumed by a large segment of the United States population and contains most of the radionuclides occurring in the environment which have been identified as being biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples which are representative of milk consumption in any area can be readily obtained.

1. PASTEURIZED MILK NETWORK, SEPTEMBER 1963

Division of Radiological Health and Division of Environmental Engineering and Food Protection, Public Health Service

The Public Health Service pasteurized milk radionuclide surveillance program had its origin in a raw milk monitoring network established by the Service in 1957. One of the primary objectives of this network was the development of methods for milk collection and radiochemical analysis suitable for larger scale programs.

Experience derived from this earlier network led to the activation of a pasteurized milk sampling program with stations selected to provide nationwide surveillance of milk production and consumption areas. More milk sampling points continued to be added until July 1962, when the total number of stations reached 62.

Through the cooperation of State and local milk sanitation authorities, samples are routinely collected at each of these stations. Composites of the samples are preserved with formaldehyde and are sent to the PHS Southwestern, Southeastern, or Northeastern Radiological Health Laboratories for analysis. Gamma analyses for iodine–131 are made within 3 to 6 days after sample collection, and any results exceeding 100 pc/liter are immediately telephoned to the States for possible public health action. Complete analytical results are available 6 to 7 weeks after collection; publication in *Radiological Health Data* follows 3 to 4 months after sample collection.

Sampling and Compositing Procedures

The method of compositing specifies that each station's sample be composited of subsamples from each milk processing plant in proportion to the plant's average sales in the community served. At most stations, the composited sample represents from 80 to 100 percent of the milk processed. Prior to September 15, 1961, the composite sample was taken from one day's

sales per month and was as representative of the community's supply as could be achieved under practical conditions. Beginning with the resumption of nuclear weapons testing in the atmosphere in September 1961, and continuing through January 1963, sampling was done twice a week at nearly all stations and daily for short periods at selected stations. Since then, the sampling frequency has been reduced to once a week.

Analytical Errors in Radionuclide Measurements

Iodine–131, cesium–137, and barium–140 concentrations are determined by gamma scintillation spectroscopy.[1] After gamma scanning, a two-week composite is analyzed radiochemically for strontium–89 and strontium–90. There is

[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, SEPTEMBER 1963[a]

[Average radioactivity concentrations in pc/liter]

Sampling locations		Calcium (g/liter)		Potassium (g/liter)		Strontium–89		Strontium–90		Cesium–137		Last Sr^{90} graph in RHD
		Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	Third quarter	Avg. for month	
Ala:	Montgomery	1.17	1.15	1.4	1.4	45	25	21	20	85	70	Oct. 63
Alaska:	Palmer	1.17	1.16	1.5	1.6	45	45	24	26	160	165	Nov. 63
Ariz.	Phoenix	1.14	1.12	1.7	1.7	5	<5	3	4	25	30	Jan. 64
Ark:	Little Rock	1.19	1.18	1.3	1.4	105	55	44	42	170	155	Nov. 63
Calif:	Sacramento	1.18	1.16	1.6	1.7	10	5	9	9	50	50	Dec. 63
	San Francisco	1.17	1.16	1.6	1.7	20	15	9	7	65	55	Oct. 63
Colo:	Denver	1.18	1.11	1.6	1.6	40	30	22	20	110	95	Dec. 63
Conn:	Hartford	1.16	1.14	1.6	1.7	40	25	31	24	215	170	Dec. 63
Del:	Wilmington	1.18	1.17	1.6	1.5	35	25	30	27	150	135	Jan. 64
D. C:	Washington	1.13	1.14	1.5	1.5	45	25	21	20	110	80	Oct. 63
Fla:	Tampa	1.19	1.17	1.4	1.4	25	20	14	14	275	290	Jan. 64
Ga:	Atlanta	1.18	1.16	1.4	1.5	75	40	33	29	190	130	Oct. 63
Hawaii:	Honolulu	1.18	1.16	1.6	1.7	15	10	12	12	85	90	Nov. 63
Idaho:	Idaho Falls	1.17	1.16	1.5	1.6	60	20	33	21	160	115	Jan. 64
Ill:	Chicago	1.21	1.18	1.6	1.6	30	20	23	20	125	110	Oct. 63
Ind:	Indianapolis	1.19	1.19	1.6	1.6	40	20	24	20	110	85	Dec. 63
Iowa:	Des Moines	1.18	1.19	1.5	1.6	50	35	28	27	85	85	Jan. 64
Kans:	Wichita	1.16	1.15	1.5	1.6	35	20	24	21	80	75	Nov. 63
Ky:	Louisville	1.14	1.14	1.4	1.5	100	50	39	35	125	80	Jan. 64
La:	New Orleans	1.21	1.20	1.4	1.5	80	50	41	40	160	145	Nov. 63
Maine:	Portland	1.18	1.16	1.6	1.6	55	40	38	36	300	265	Jan. 64
Md:	Baltimore	1.14	1.12	1.4	1.5	60	35	25	22	145	100	Jan. 64
Mass:	Boston	1.18	1.15	1.6	1.6	70	50	47	40	320	290	Oct. 63
Mich:	Detroit	1.17	1.15	1.6	1.6	30	20	22	18	130	130	Dec. 63
	Grand Rapids	1.18	1.17	1.6	1.7	35	25	22	22	145	150	Jan. 64
Minn:	Minneapolis	1.17	1.14	1.5	1.6	70	40	34	30	170	140	Oct. 63
Miss:	Jackson	1.22	1.21	1.4	1.5	80	40	36	34	125	95	Dec. 63
Mo:	Kansas City	1.15	1.16	1.6	1.5	55	55	29	32	75	65	Dec. 63
	St. Louis	1.16	1.17	1.5	1.6	45	25	25	22	85	75	Nov. 63
Mont:	Helena	1.16	1.16	1.4	1.5	80	40	39	30	245	185	Nov. 63
Nebr:	Omaha	1.17	1.16	1.6	1.7	50	30	29	25	100	90	Jan. 64
Nev:	Las Vegas	1.16	1.15	1.6	1.6	20	15	12	10	90	85	Oct. 63
N. H:	Manchester	1.20	1.20	1.6	1.6	60	50	43	38	355	310	Jan. 64
N. J:	Trenton	1.16	1.09	1.6	1.6	30	20	26	22	160	130	Dec. 63
N. Mex:	Albuquerque	1.12	1.04	1.6	1.6	20	10	12	12	50	50	Nov. 63
N. Y:	Buffalo	1.16	1.17	1.7	1.7	40	25	26	25	170	170	Dec. 63
	New York	1.14	1.12	1.6	1.6	60	40	41	37	225	215	Oct. 63
	Syracuse	1.19	1.19	1.6	1.6	45	35	31	28	165	155	Nov. 63
N. C:	Charlotte	1.17	1.14	1.4	1.5	80	40	35	35	155	125	Nov. 63
N. Dak:	Minot	1.16	1.18	1.5	1.6	130	100	60	56	170	160	Jan. 64
Ohio:	Cincinnati	1.20	1.18	1.6	1.6	40	20	28	25	95	70	Dec. 63
	Cleveland	1.16	1.18	1.6	1.6	40	25	24	20	125	110	Nov. 63
Okla:	Oklahoma City	1.13	1.13	1.4	1.4	55	30	22	20	90	75	Oct. 63
Ore:	Portland	1.22	1.21	1.4	1.5	50	35	33	33	190	190	Dec. 63
Pa:	Philadelphia	1.15	1.18	1.6	1.6	35	20	26	22	140	115	Nov. 63
	Pittsburgh	1.20	1.18	1.6	1.6	60	30	36	34	190	170	Nov. 63
P. R:	San Juan	1.14	1.14	1.4	1.4	35	15	14	12	95	65	Nov. 63
R. I:	Providence	1.19	1.19	1.7	1.7	45	25	35	28	225	180	Jan. 64
S. C:	Charleston	1.17	1.17	1.4	1.4	60	35	26	25	150	140	Dec. 63
S. Dak:	Rapid City	1.07	1.23	1.5	1.7	100	60	49	47	175	150	Oct. 63
Tenn:	Chattanooga	1.20	1.16	1.4	1.4	110	50	46	38	185	120	Oct. 63
	Memphis	1.18	1.20	1.4	1.5	75	30	33	30	100	70	Jan. 64
Tex:	Austin	1.14	1.17	1.5	1.5	20	10	10	14	55	60	Oct. 63
	Dallas	1.16	1.14	1.5	1.5	40	20	19	17	75	60	Dec. 63
Utah:	Salt Lake City	1.13	1.03	1.5	1.7	55	30	30	25	205	160	Nov. 63
Vt:	Burlington	1.16	1.16	1.6	1.7	55	40	39	32	245	230	Dec. 63
Va:	Norfolk	1.15	1.14	1.4	1.5	45	20	23	23	115	95	Dec. 63
Wash:	Seattle	1.20	1.20	1.5	1.6	55	40	36	36	205	205	Oct. 63
	Spokane	1.22	1.20	1.5	1.6	55	30	30	26	160	140	Dec. 63
W. Va:	Charleston	1.13	1.14	1.4	1.5	85	45	34	30	120	85	Oct. 63
Wis:	Milwaukee	1.24	1.24	1.8	1.8	30	20	21	17	130	120	Jan. 64
Wyo:	Laramie	1.15	1.14	1.5	1.5	45	25	27	20	125	125	Jan. 64
Network average		1.17	1.16	1.5	1.6	52	31	28.4	25.6	147	128	Nov. 63

[a] The monthly average iodine-131 and barium-140 concentration at each station was < 10 pc/liter.

an inherent statistical variation associated with all measurements of radionuclide concentrations. With the low radionuclide levels which are usually found in milk and other environmental samples, this variation on a percentage basis is relatively high. The variation is dependent upon such factors as the method of chemical analysis, the sample counting rate and counting time, interferences from other radionuclides, and the background count. For milk samples, counting times of 50 minutes for gamma spectroscopy and 30 to 50 minutes for low background beta determinations are used. The minimum detectable concentration is defined as the measured concentration at which the statistical two-standard-deviation analytical error is 100 percent (*1*). Accordingly, the minimum detectable concentrations in units of pc/liter are Sr^{89}, 5; Sr^{90}, 1; Cs^{137}, 5; Ba^{140}, 10; and I^{131}, 10.

Data Presentation

Table 1 presents summaries of the analyses for September 1963 (September 1-28, 1963). Although not shown in table 1, the iodine–131 and barium–140 monthly average concentrations in milk were <10 pc/liter. When a radionuclide is reported by a laboratory as being below the minimum detectable concentration, one-half the minimum detectable value is used in calculating the monthly average. A similar procedure is used for the network average.

Figures 1, 2, and 3 are isoconcentration maps showing the estimated strontium–89, strontium–90, and cesium–137 concentration in milk over the entire country. The value printed beside each station is the monthly average concentration for that station. In order to show the distribution of the network's stations versus radionuclide concentrations in milk, table 2 has

TABLE 2.—DISTRIBUTION OF SAMPLING STATIONS IN VARIOUS RANGES OF RADIONUCLIDE CONCENTRATIONS IN MILK, SEPTEMBER 1963

Strontium-89		Strontium-90		Iodine-131		Cesium-137		Barium-140	
Range (pc/liter)	Number of stations	Range (pc/liter)	Number of stations	Range (pc/liter)	Number of stations	Range (pc/liter)	Number of stations	Range (pc/liter)	Number of stations
<5–10	5	<1–9	3	<10	62	<5–45	1	<10	62
15–20	15	10–19	9			50–95	24		
25–30	17	20–29	29			100–145	17		
35–40	14	30–39	16			150–195	13		
45–50	7	40–49	4			200–245	3		
55–60	3	50–59	1			250–295	3		
65–70	0					300–345	1		
>70	1								

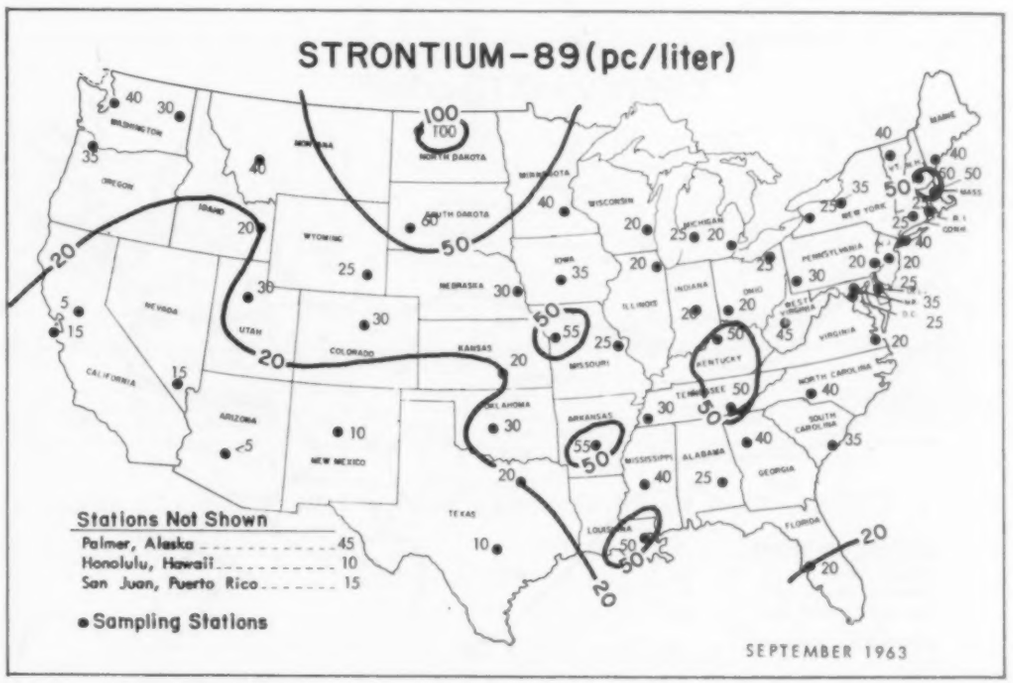

FIGURE 1.—STRONTIUM–89 CONCENTRATIONS IN PASTEURIZED MILK

been prepared using monthly average data shown in table 1.

Continuing the practice followed in previous issues of *Radiological Health Data*, the average monthly strontium–90 concentrations in pasteurized milk from 16 selected cities in the sampling program are presented in figure 4. Each graph shows the strontium–90 concentrations in milk from one city in each of the four U. S. Bureau of Census regions. This method of selection permits graphic presentation of data for each city in the network at least twice a year.

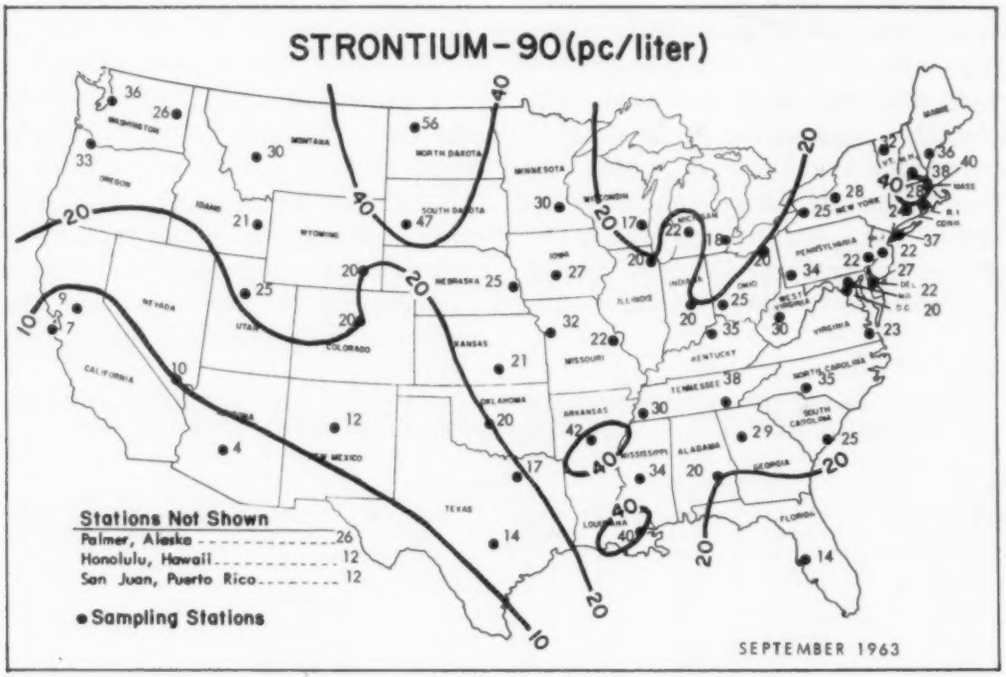

FIGURE 2.—STRONTIUM–90 CONCENTRATIONS IN PASTEURIZED MILK

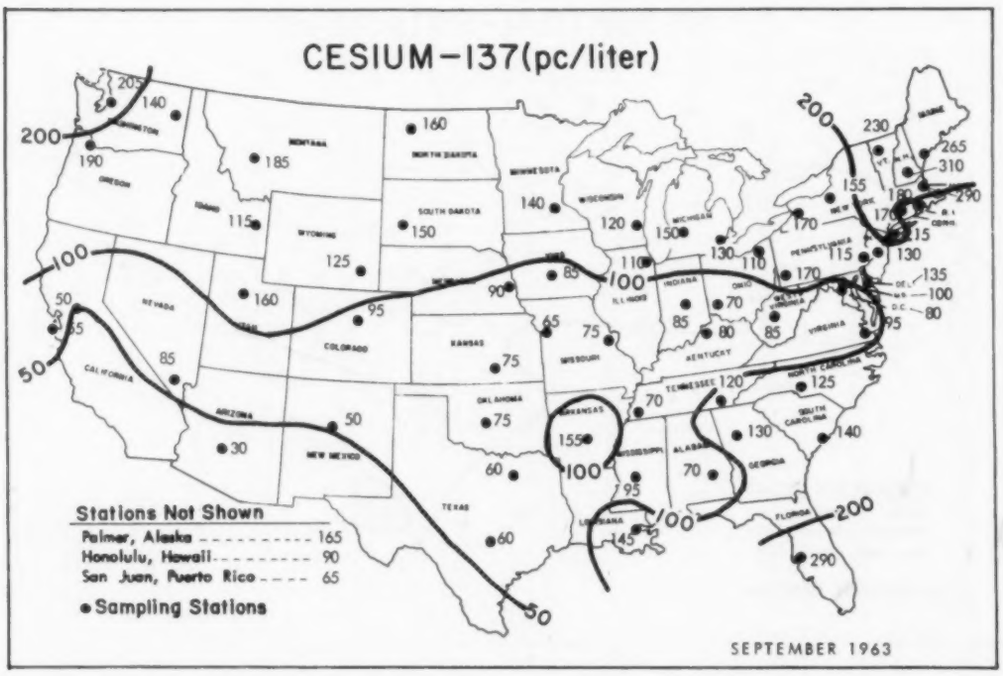

FIGURE 3.—CESIUM–137 CONCENTRATIONS IN PASTEURIZED MILK

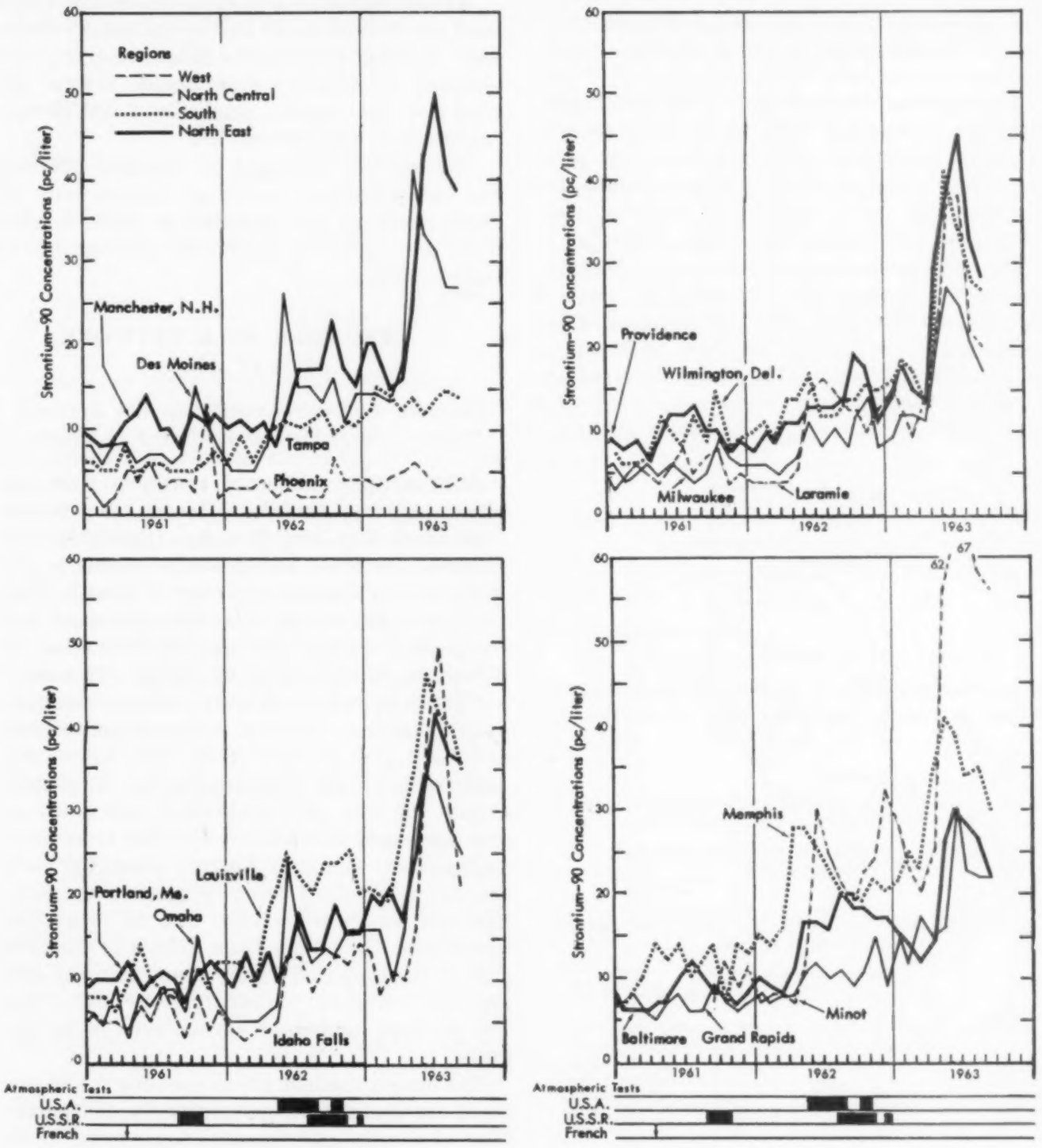

FIGURE 4.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

2. INDIANA MILK NETWORK, SEPTEMBER 1963

Bureau of Environmental Sanitation
Indiana State Board of Health

The Indiana State Board of Health began sampling pasteurized milk for radiological analysis in September 1961. Indiana was geographically divided into five major milksheds, and one large dairy within each milkshed was selected as a sampling station (see figure 5).

The milk samples are routinely analyzed for iodine–131, cesium–137, barium–140, strontium–89 and strontium–90. Until August 1963, analyses for the gamma emitters iodine–131, cesium–137 and barium–140 were conducted on a weekly basis, except when iodine–131 exceeded 100 pc/liter, at which times the frequency of sampling was increased. Because of continued low concentrations of the short-half-lived gamma emitters, the sampling frequency was reduced in August 1963 to once per month for the northeast, southeast and southwest milksheds. Strontium–89 and strontium–90 analyses are performed monthly for each station.

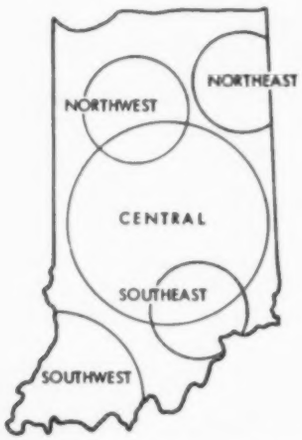

FIGURE 5.—INDIANA MILK SAMPLING LOCATIONS

TABLE 3.—RADIONUCLIDES IN INDIANA MILK, SEPTEMBER 1963

[Concentrations in pc/liter]

Sampling location	Sr^{89}	Sr^{90}	I^{131}	Cs^{137}	Ba^{140}
Northeast	< 10	31	< 10	100	< 10
Southeast	< 10	34	< 10	60	< 10
Central	< 10	37	< 10	70	< 10
Southwest	< 10	34	< 10	55	< 10
Northwest	< 10	44	< 10	100	< 10
State average	< 10	36	< 10	75	< 10

An ion exchange analytical procedure (*2*) is used for strontium–89 and strontium–90 analyses. A 512-channel pulse height analyzer and shielded 4 x 4-inch sodium iodide crystal are used for the gamma analysis of iodine–131, cesium–137, and barium–140.

The monthly averages of the data obtained for the individual sampling stations and the State averages are reported in table 3. The State average is an arithmetic average of the station values.

3. NEW YORK MILK NETWORK, AUGUST 1963

Division of Environmental Health Services
State of New York Department of Health

Milk samples, collected routinely from six cities—Albany, Buffalo, Massena, Newburgh, New York City, and Syracuse (figure 6)—are analyzed for their radionuclide content by the State of New York Department of Health. Pasteurized milk samples are collected daily and composited weekly for the determination of strontium–89, strontium–90, iodine–131, cesium –137, and barium-lanthanum–140 at all stations except Massena, where samples are composited bi-weekly and at New York City where one daily milk sample representing the total milk supply for that day is obtained and analyzed once per week. Samples are obtained from processing plants except at Albany, where the daily sample is obtained from a marketing point. During periods when cows are no longer on stored feed, the sample from Albany is analyzed daily for iodine–131. In the event that any city reports iodine–131 concentrations exceeding 100 pc/liter, increased surveillance is undertaken.

The matrix method (*3*) is used for the analysis of spectral data to determine the concentrations of gamma-emitting nuclides in milk. With this method, the individual nuclide contributions to the gamma spectrum are separated by solution of simultaneous equations describing the spectral interferences.

The analytical procedure for strontium–89 and strontium–90 is based on ion exchange methods. Cations (including radiostrontium) are eluted from the ion exchange resin with

FIGURE 6.—NEW YORK MILK SAMPLING LOCATIONS

sodium chloride solution, strontium isotopes are gathered by means of sodium carbonate, isolated by means of ethylenediaminetetraacetic acid (EDTA), and radiostrontium is counted with a low background beta counter having an 0.8 mg/cm^2 window. The strontium–90 portion is differentally estimated by a second count 40 hours later to determine the rate of growth of its daughter product yttrium–90. The monthly average radionuclide concentrations in milk are shown in table 4.

TABLE 4.—RADIONUCLIDES IN NEW YORK MILK, AUGUST 1963

[Average concentrations in pc/liter]

Sampling location	Sr^{89}	Sr^{90}	I^{131}	Cs^{137}	Ba-La^{140}
Albany	49	29	<20	132	<20
Buffalo	33	20	<20	93	<20
Massena	50	31	<20	226	<20
Newburgh	53	37	<20	134	<20
New York City	81	33	<20	133	<20
Syracuse	36	29	<20	110	<20
Average	50	30	<20	138	<20

Note: Ba-La^{140} refers to the sum of these two nuclides in equilibrium.

4. RADIOSTRONTIUM IN MILK,[1] APRIL-JUNE 1963

Health and Safety Laboratory
U. S. Atomic Energy Commission

The Health and Safety Laboratory began monitoring liquid whole milk in New York City in 1954 for strontium–90 in order to estimate the dietary contribution from the ingestion of radiostrontium in milk. Subsequently, powdered milk monitoring was initiated at Perry, New York, in 1954 and at Mandan, North Dakota in 1955. Liquid whole milk monitoring was started in Honolulu, Hawaii, in August 1959.

The New York City sample is a monthly composite of pasteurized milk purchased daily in quart containers at retail stores. Five large dairies are represented in the sample. The Honolulu samples are monthly composites of quart samples of pasteurized milk collected weekly. Samples from two dairies are analyzed and the results are averaged. The Mandan and Perry samples are monthly composites of powdered milk collected in 5-pound lots from plants in each city. The Mandan sample is powdered buttermilk used for cattle feed, while the Perry sample is powdered whole milk used for human consumption. The source of the Honolulu milk is from the island of Oahu where the cows are on pasture throughout the year, and it is of interest to know how well the strontium levels in milk in this area reflect changes in deposition rates.

The calcium and strontium–90 data are presented in tables 5 and 6. The fluctuations of strontium–90 with time are shown in figures 7 and 8.

TABLE 5.—RADIOSTRONTIUM AND CALCIUM IN LIQUID MILK, APRIL–JUNE 1963

Sampling station and period	Calcium (g/liter)	Strontium–90 (pc/liter)	Strontium–90 (pc/g Ca)
New York City			
1959 Average			11
1960 Average			8.0
1961 Average			6.7
1962 Average			12
1963 First Quarter			11
April	0.96	11.6	12.1
May	1.00	40.8	40.6
June	1.00	42.4	42.4
Honolulu, Hawaii			
1959 Average			5.0
1960 Average			3.2
1961 Average			2.4
1962 Average			4.3
1963 Average			6.0
April	1.14	9.1	8.0
May	1.06	10.2	9.6
June	1.07	10.1	9.5

Comment

A marked increase in the strontium–90 content of milk from the continental U.S. stations was observed beginning in May 1963, due to the heavy spring fallout deposition.

[1] Data taken from *HASL–140* (4).

The Honolulu milk samples still contain less strontium–90 per liter than those of other sampling stations, although there was a slight increase in strontium–90 concentrations in the Honolulu samples in May also.

TABLE 6.—RADIOSTRONTIUM AND CALCIUM IN POWDERED MILK AND BUTTERMILK, APRIL–JUNE 1963

Sampling station and period	Calcium (g/kg)	Strontium–90 (pc/kg)	Strontium–90 (pc/g Ca)
Powdered milk			
Perry, New York			
1959 Average			8.0
1960 Average			6.5
1961 Average			6.2
1962 Average			11.1
1963 First Quarter			11.9
April	7.8	92	11.8
May	8.7	158	18.3
June	5.6	171	30.5
Powdered Buttermilk			
Mandan, North Dakota			
1959 Average			25.7
1960 Average			15.0
1961 Average			9.4
1962 Average			25
1963 First Quarter			29.3
April	12.6	532	42.4
May	11.6	1214	105
June	16.8	950	56.5

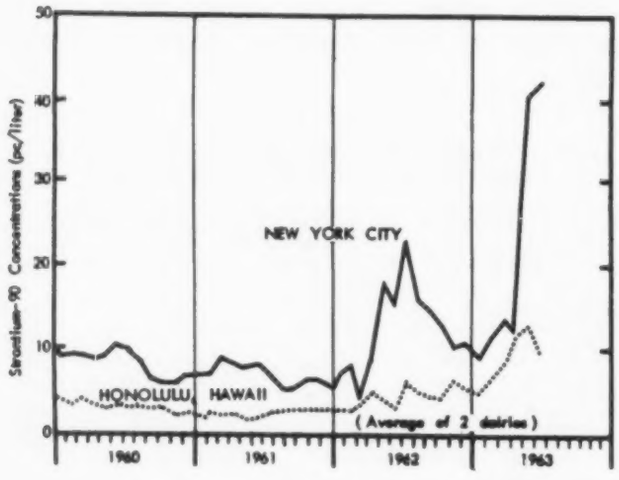

FIGURE 7.—STRONTIUM–90 IN LIQUID MILK SAMPLES

Recent coverage in *Radiological Health Data*:

Period	Issue
August–December 1961	*June 1962*
January–February 1962	*September 1962*
March–June 1962	*January 1963*
July–September 1962	*April 1963*
October 1962–March 1963	*October 1963*

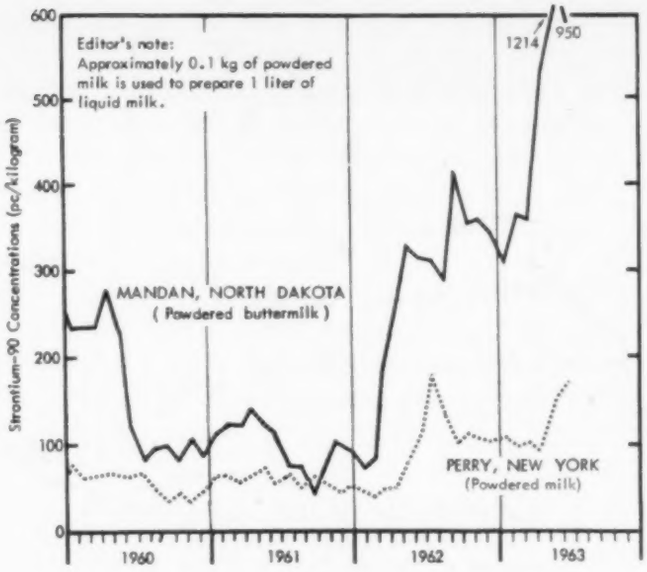

FIGURE 8.—STRONTIUM–90 IN POWDERED MILK SAMPLES

5. CANADIAN MILK NETWORK,[1] SEPTEMBER 1963

Radiation Protection Division
Department of National Health and Welfare,
Ottawa, Canada

The Radiation Protection Division of the Department of National Health and Welfare began monitoring milk for strontium–90 in November 1955. At first, analyses were carried out on samples of powdered milk obtained from processing plants. However, since January 1963, liquid whole milk has been analyzed instead. With this change, more representative samples can be obtained, and in addition it is possible to choose milk sampling locations (see figure 9) in the same areas as the air and precipitation stations. At present, the analyses include determinations of iodine–131, strontium–89 and cesium–137, as well as strontium–90.

The milk samples are obtained through the cooperation of the Marketing Division of the Canadian Department of Agriculture. At each station samples are collected three times a week from selected dairies, combined into weekly composites, and forwarded to the radiochemical laboratory in Ottawa for analysis. The contri-

[1] Data from *Radiation Protection Programs, Vol. 1, No. 10*: 25–31, Radiation Protection Division, Canadian Department of National Health and Welfare. (October 1963).

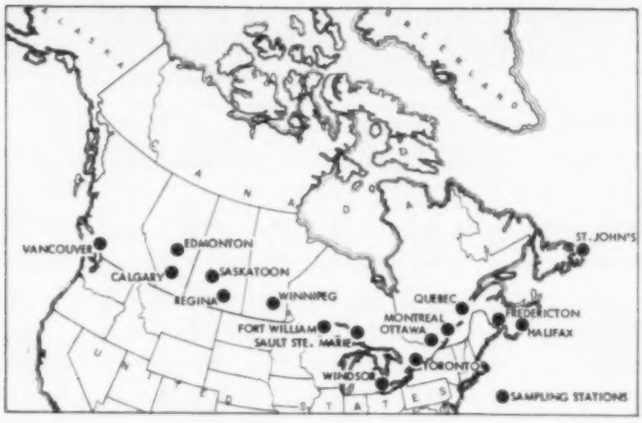

FIGURE 9.—CANADIAN MILK SAMPLING STATIONS

bution of each dairy to the composite sample is directly proportional to its volume of sales. In most cases a complete sample represents over 80 percent of the milk processed and distributed in the area. Iodine–131 is determined on a portion of each sample; the remaining portion is combined into monthly composites for the determination of strontium–90, strontium–89 and cesium–137.

Analytical Methods

For the analysis of iodine–131, radiochemical methods (*5*) are used. Carrier iodine is added and the milk is then evaporated in the presence of sodium hydroxide and ashed. The iodide ion is oxidized to free iodine and extracted with carbon tetrachloride, back-extracted in sulphite solution, and precipitated as silver iodide. The precipitate is counted in a low background beta counter and the iodine–131 determined by comparison with standard preparations.

For the analysis of radiostrontium, carrier strontium is added to a one-liter sample of milk, and the milk is then evaporated under infra-red lamps in a tray lined with polyethylene sheet. The residue is ashed in a muffle furnace at 450° C, dissolved in dilute nitric acid, and strontium is separated on an ion-exchange column (*6, 7*). The combined strontium–89 and strontium–90 are determined by counting in a low background beta counter. Strontium–90 is determined separately by extracting and counting the yttrim–90 daughter isotope, while strontium–89 is estimated by difference from the total radiostrontium measurement. Appropriate corrections are made for self-absorption and counter efficiency at all stages.

Cesium–137 is determined by gamma spectrometry using a scintillation crystal and a multi-channel pulse height analyzer. A sample consisting of 4.5 liters of milk is placed in a sample tray constructed in the form of an inverted well to accommodate the 5 × 4-inch sodium iodide crystal detector. The sample is counted for 100 minutes and the gamma spectrum recorded. Estimates are made of the potassium–40 and cesium–137 content of the milk by comparison of the spectrum with standard preparations.

Sources of Error

In the iodine and strontium determinations, tests indicate that the statistical error (95 percent confidence level) in the chemical operations involved is about plus-or-minus 10 percent. This value is independent of the concentration of the radioisotope in the milk because it depends only on the recovery of the "carrier". In the determination of cesium this factor is not involved.

The operational error must be combined with the counting error, which depends primarily on the concentration of the nuclide in the sample, the background radiation, and the length of time the sample and background are counted. This counting error has been evaluated mathematically for the particular counting arrangement used.

The overall errors, estimated on the basis indicated above, are given in reference (*8*). For example, the 2σ total errors (representing 95 percent confidence) associated with a measured concentration of 10 pc/liter, in units of pc/liter are Sr^{89}, 2.5; Sr^{90}, 1.5; I^{131}, 5; and Cs^{137}, 6.

Results

Table 7 presents monthly averages of strontium–89, strontium–90, cesium–137, iodine–131, and stable calcium and potassium in Canadian whole milk. Figures 10 and 11 show the variation of the network average of the radionuclides content of Canadian whole milk.

Discussion

It should be emphasized that the interpretation of fallout data in relation to health is a complex problem. In comparing the concentration levels in a particular medium with the

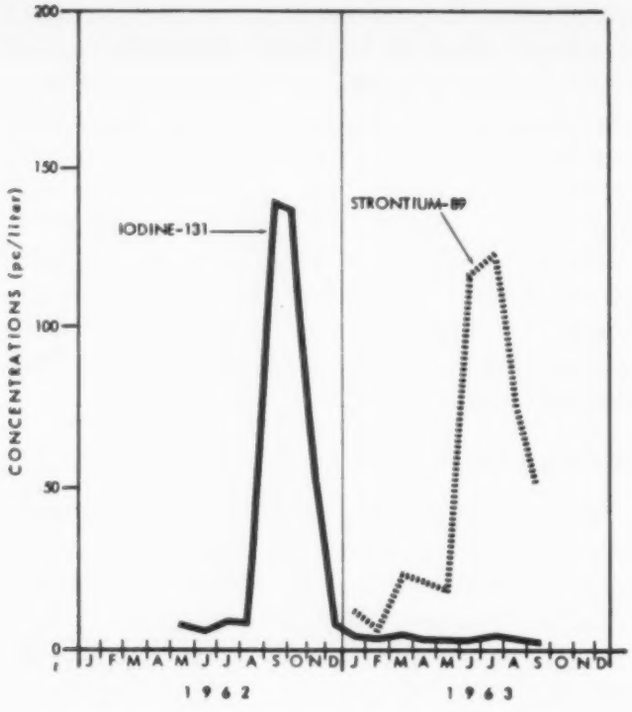

FIGURE 10.—IODINE–131 AND STRONTIUM–89 CONCENTRATIONS IN CANADIAN WHOLE MILK

Maximum Permissible Concentrations (MPC's) as established by the International Commission on Radiological Protection (*9*), it is necessary to keep in mind that the MPC values refer to conditions of continuous exposure over a lifetime. Therefore, the average levels over an extended period such as one year represent a better basis for comparison than do individual levels at any specific time.

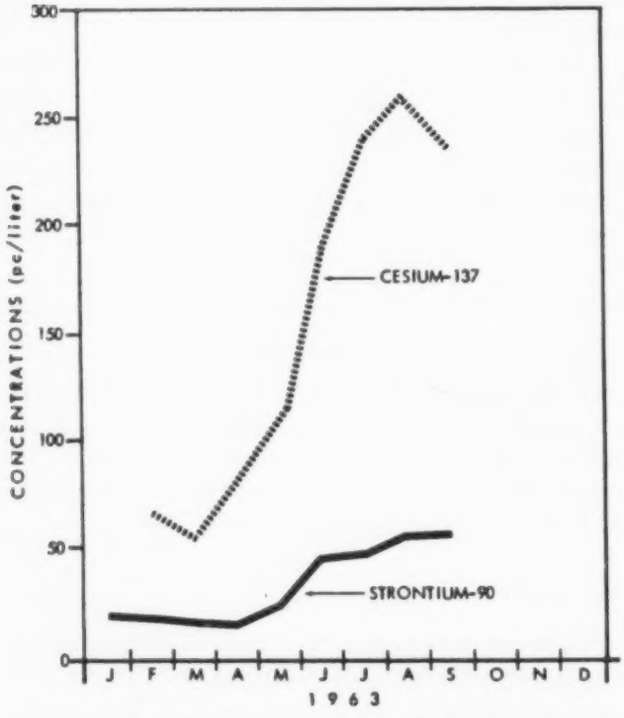

FIGURE 11.—STRONTIUM–90 AND CESIUM–137 CONCENTRATIONS IN CANADIAN WHOLE MILK

TABLE 7.—RADIONUCLIDES IN CANADIAN WHOLE MILK, SEPTEMBER 1963

[Radionuclide Concentrations in pc/liter]

Station	Calcium (g/liter)	Potassium (g/liter)	Strontium–89	Strontium–90	Iodine–131	Cesium–137
Calgary	1.36	1.4	60	53.2	1	209
Edmonton	1.34	1.5	47	44.2	2	188
Ft. William	1.32	1.5	69	58.5	0	264
Fredericton	1.34	1.5	79	80.4	1	382
Halifax	1.30	1.4	59	74.2	0	282
Montreal	1.29	1.5	65	54.4	0	219
Ottawa	1.26	1.5	31	40.4	2	196
Quebec	1.30	1.6	44	49.2	1	338
Regina	1.34	1.5	70	78.2	1	149
St. John's, Nfld.	1.21	1.4	62	72.4	2	280
Saskatoon	1.32	1.5	32	27.2	0	171
Sault Ste. Marie	1.31	1.5	56	65.1	1	264
Toronto	1.31	1.4	30	22.1	5	153
Vancouver	1.42	1.5	43	49.3	3	341
Windsor	1.35	1.4	13	16.3	0	54
Winnipeg	1.15	1.5	53	51.7	5	216
Average	1.31	1.5	51	52.3	2	232

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(*3*) Kahn, B., et al.: *Rapid Methods for Estimating Fission Product Concentrations in Milk, Public Health Service Publication No. 999–R–2*, (March 1963). Single copies available on request from Public Inquiries Branch, PHS, U.S. Department of Health, Education and Welfare, Washington, D.C. 20201

(*4*) U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–140*, 154–6, Office of Technical Services, Department of Commerce, Washington, D.C. 20401 (October 1, 1963), price $4.00.

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(*8*) Public Health Service: Canadian Milk Network, *Radiological Health Data 4*: 561–3, Superintendent of Documents, Government Printing Office, Washington D.C. 20401 (November 1963).

(*9*) International Commission on Radiological Protection: *Report of Committee II on Permissible Dose for Internal Radiation*, Pergamon Press, New York (1959).

Moving Annual Average Radionuclide Concentrations in Pasteurized Milk, October 1962—September 1963

Radionuclide concentration values reported by the Pasteurized Milk Network (*1*) may be used to assess that portion of an individual's or a population's radiation dose attributable to milk consumption by determining both the annual average concentrations of specific radionuclides of interest in milk and the average daily milk consumption of an individual or a suitable sample of the population.

The data listed in table 1 are concerned with the first of these requirements, *i.e.*, annual average concentrations of strontium–89, strontium–90 and iodine–131 in one liter of pasteurized milk. Limited data are available for estimating the average daily milk consumption (on a volume basis) for specific age groups in the U.S. population (*2*, *3*).

Employing an assumption that the average daily milk consumption of an individual in a population group is one liter, permits comparisons to be made between the daily rates of intake of the above radionuclides from the milk component of the diet and the Federal Radiation Council's action ranges of transient daily rates of intake (*4*). The upper limits of Range II correspond to the Radiation Protection Guide (RPG) for iodine–131 and one third of the Radiation Protection Guide for radioactive strontium. The Guides are, for administrative reasons, expressed as a yearly radiation dose, but are based on lifetime exposure (*5*). The FRC emphasizes that the annual acceptable risk or exposure dose is not a dividing line between safety and danger in actual radiation situations (*6*).

Annual averages of radionuclide concentrations in milk, sampled by the PHS Pasteurized Milk Network, are presented in table 1. These averages are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the averages for all weeks ending in 12 consecutive months are averaged to obtain the annual average. To obtain the annual average daily intake (pc/day) of radionuclides from milk, the annual average concentration values (pc/liter), in table 1 must be multiplied by the annual average daily consumption (liters/day) of milk (*3*, *4*).

Monthly variations of radionuclide concentrations in milk are due to a number of combined causes. The moving yearly average (table 1), obtained by updating the previous twelve-month average by one month, shows variations averaged over the year and tends to minimize purely seasonal variations. This method, therefore, shows trends over a considerable period of time.

REFERENCES

(*1*) Public Health Service: Pasteurized Milk Network, *Radiological Health Data*, *4*: 551–557, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (November 1963).

(*2*) Bureau of the Census, Department of Commerce, and Public Health Service: National Food Consumption Survey, Fresh Whole Milk Consumption in the United States, July 1962, *Radiological Health Data* *4*: 15–17, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (January 1963).

(*3*) Bureau of the Census and Public Health Service: Consumption of Selected Food Items in U.S. Households, July 1962, *Radiological Health Data*, *4*: 124–7, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., (March 1963).

(*4*) Federal Radiation Council: Radiation Protection Guidance for Federal Agencies, *Federal Register*, Superintendent of Documents, Government Printing Office, Washington 25, D.C., (September 26, 1961).

(*5*) Federal Radiation Council: *Background Material for the Development of Radiation Protection Standards, Report No. 2*, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. (September 1961), price 20 cents.

(*6*) Public Health Service: Special Report, *Radiological Health Data*, *3*: ii–iii, Superintendent of Documents, Government Printing Office, Washington 25, D.C., (September 1962).

TABLE 1.—ANNUAL AVERAGE RADIONUCLIDE CONCENTRATIONS IN MILK

[Concentrations in pc/liter]

Sampling locations		Iodine-131		Strontium-89		Strontium-90	
		September 1962–August 1963[a]	October 1962–September 1963[b]	September 1962–August 1963[a]	October 1962–September 1963[b]	September 1962–August 1963[a]	October 1962–September 1963[b]
Ala:	Montgomery	16	15	67	68	19	19
Alaska:	Palmer	100	32	58	46	15	16
Ariz:	Phoenix	<10	<10	18	18	4	4
Ark:	Little Rock	37	36	137	139	38	40
Calif:	Sacramento	<10	<10	42	42	8	9
	San Francisco	11	<10	73	75	12	12
Colo:	Denver	11	<10	29	27	14	15
Conn:	Hartford	20	14	30	29	18	19
Del:	Wilmington	30	24	41	39	22	23
D. C:	Washington	22	17	46	46	19	19
Fla:	Tampa	18	18	36	37	13	13
Ga:	Atlanta	22	22	92	94	25	26
Hawaii:	Honolulu	11	11	36	37	8	9
Idaho:	Idaho Falls	17	14	46	45	19	20
Ill:	Chicago	28	20	29	28	18	18
Ind:	Indianapolis	29	23	41	39	20	20
Iowa:	Des Moines	41	31	74	72	20	22
Kans:	Wichita	25	23	53	52	17	18
Ky:	Louisville	26	23	103	104	29	30
La:	New Orleans	26	26	148	149	36	37
Maine:	Portland	20	15	37	35	23	25
Md:	Baltimore	22	17	53	53	20	20
Mass:	Boston	21	15	41	41	27	29
Mich:	Detroit	32	21	29	26	18	19
	Grand Rapids	24	18	26	24	16	17
Minn:	Minneapolis	29	21	63	59	25	26
Miss:	Jackson	24	25	147	148	30	31
Mo:	Kansas City	38	34	86	86	22	23
	St. Louis	23	19	58	57	19	19
Mont:	Helena	32	25	55	54	22	23
Nebr:	Omaha	35	29	60	58	21	22
Nev:	Las Vegas	<10	<10	22	20	7	8
N. H:	Manchester	19	14	39	38	25	27
N. J:	Trenton	21	17	32	30	19	19
N. Mex:	Albuquerque	13	11	25	25	7	8
N. Y:	Buffalo	22	13	31	29	19	20
	New York	30	22	39	39	23	25
	Syracuse	24	16	34	32	20	21
N. C:	Charlotte	<10	<10	73	74	27	28
N. Dak:	Minot	33	18	85	87	37	40
Ohio:	Cincinnati	34	27	51	48	22	23
	Cleveland	29	21	34	33	18	19
Okla:	Oklahoma City	32	31	77	77	22	22
Ore:	Portland	22	20	102	104	23	25
Pa:	Philadelphia	27	22	37	36	21	22
	Pittsburgh	36	31	45	44	24	25
P. R:	San Juan	[b]15	[d]15	[c]87	[d]88	[c]14	[d]14
R. I:	Providence	22	18	36	34	22	24
S. C:	Charleston	18	18	72	74	24	24
S. Dak:	Rapid City	34	22	70	71	26	28
Tenn:	Chattanooga	20	19	118	120	31	33
	Memphis	26	25	105	106	28	29
Tex:	Austin	30	30	39	39	8	9
	Dallas	47	47	91	92	20	20
Utah:	Salt Lake City	18	15	36	36	17	18
Vt:	Burlington	22	17	39	36	22	23
Va:	Norfolk	17	15	54	53	21	21
Wash:	Seattle	21	19	76	77	21	23
	Spokane	18	13	53	54	20	21
W. Va:	Charleston	16	14	76	76	27	28
Wis:	Milwaukee	35	25	30	28	15	16
Wyo:	Laramie	11	<10	52	46	18	19
Network summary		25	19	58	58	20.4	21.2

[a] Annual averages were computed on basis of 53 weekly averages.
[b] Annual averages were computed on basis of 52 weekly averages.
[c] Average is for 49 weeks. (No sample was received in November 1962).
[d] Average is for 48 weeks. (No sample was received in November 1962).

SECTION III.—WATER

Radioactivity in Raw Surface Waters—National Water Quality Network, July 1963

Division of Water Supply and Pollution Control,
Public Health Service

Levels of radioactivity in surface waters of the United States have been under surveillance by the Public Health Service National Water Quality Network since its initiation in 1957. Beginning with the establishment of 50 sampling points, this Network has expanded to 128 stations as of December 1, 1963 (figure 1), operated jointly with State, Federal, and local agencies, and industry. Samples are taken from surface waters of all the major U.S. river basins for physical, chemical, biological and radiological analyses. These data can be used for evaluating sources of radioactivity which may affect specific domestic, commercial, and recreational uses of surface water. Further, the Network provides background information necessary for recognizing pollution and water quality trends and for determining levels of

FIGURE 1.—TOTAL BETA ACTIVITY (pc/liter) IN SURFACE WATER AT NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, JULY 1963

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS, JULY 1963

[Average concentrations in pc/liter]

Station	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Allegheny River: Pittsburgh, Pa	4	24	28	0	0	0
Animas River: Cedar Hill, N. Mexico	111	23	134	20	2	22
Apalachicola River: Chattahoochee, Fla	8	18	26	0	0	0
Arkansas River:						
Coolidge, Kansas	1284	103	1387	103	19	122
Ponca City, Okla	305	69	374	30	2	32
Fort Smith, Ark	266	86	352	25	2	27
Little Rock, Ark	78	62	140	2	1	3
Pendleton Ferry, Ark	73	59	132	4	0	4
Bear River: Preston, Idaho	5	50	55	0	1	1
Big Horn River: Hardin, Mont	84	36	120	16	9	25
Big Sioux River: Sioux Falls, S. Dak	139	97	236	2	6	8
Chattahoochee River:						
Atlanta, Ga	13	0	13	1	0	1
Columbus, Ga	12	18	30	0	0	0
Lanett, Ala	60	20	80	1	0	1
Chena Slough: Fairbanks, Alaska	6	10	16	0	0	0
Clearwater River: Lewiston, Idaho	13	11	24	0	0	0
Clinch River:						
Clinton, Tenn	13	13	26	<1	0	<1
Kingston, Tenn	19	164	183	<1	2	2
Colorado River:						
Loma, Colo	57	67	124	8	14	22
Page, Ariz	8	72	80	0	7	7
Boulder City, Nev	0	35	35	0	12	12
Parker Dam, Calif-Ariz	0	19	19	0	9	9
Yuma, Ariz	0	129	129	0	2	2
Columbia River:						
Northport, Wash	5	17	22	0	0	0
Wenatchee, Wash	4	10	14	0	1	1
Pasco, Wash	31	258	289	0	0	0
McNary Dam, Oreg	42	203	245	0	<1	<1
Bonneville, Oreg	30	128	158	0	1	1
Clatskanie, Oreg	27	113	140	0	0	0
Cumberland River: Clarksville, Tenn	14	19	33	0	0	0
Connecticut River:						
Wilder, Vt	13	16	29	0	0	0
Northfield, Mass	22	15	37	1	0	1
Enfield Dam, Conn	17	23	40	0	0	0
Cuyahoga River: Cleveland, Ohio	12	51	63	<1	1	1
Delaware River:						
Martins Creek, Pa	10	20	30	0	0	0
Philadelphia, Pa	11	24	35	0	0	0
Escambia River: Century, Florida	9	20	29	0	0	0
Great Lakes:						
Duluth, Minn	0	9	9	0	0	0
Sault Ste. Marie, Mich	2	13	15	0	0	0
Milwaukee, Wisc	0	9	9	0	1	1
Gary, Ind	2	28	30	1	3	4
Port Huron, Mich	0	9	9	0	0	0
Detroit, Mich	0	12	12	0	0	0
Buffalo, New York	18	19	37	0	0	0
Green River: Dutch John, Utah	3	25	28	0	2	2
Hudson River: Poughkeepsie, N. Y	2	2	4	0	0	0
Illinois River:						
Peoria, Ill	16	34	50	0	0	0
Grafton, Ill	54	32	86	10	0	10
Kanawha River: Winfield Dam, W. Va	0	19	19	0	0	0
Klamath River: Keno, Oreg	3	13	16	0	0	0
Kansas River: De Soto, Kans	261	61	322	22	2	24
Maumee River: Toledo, Ohio	7	57	64	<1	1	1
Little Miami River: Cincinnati, Ohio	0	42	42	1	1	2
Merrimack River: Lowell, Mass	15	26	41	0	0	0
Mississippi River:						
St. Paul, Minn	10	63	73	1	3	4
Dubuque, Iowa	0	46	46	0	1	1
Burlington, Iowa	15	46	61	0	0	0
E. St. Louis, Ill	81	44	125	5	2	7
Cape Girardeau, Mo	83	36	119	19	4	23
W. Memphis, Ark	24	35	59	1	1	2
Vicksburg, Miss	50	33	83	5	1	6
Delta, La	70	10	80	9	0	9
New Orleans, La	8	32	40	0	1	1
Missouri River:						
Williston, N. Dak	10	47	57	0	2	2
Bismarck, N. Dak	3	34	37	0	3	3
Yankton, S. Dak	7	35	42	0	4	4
Omaha, Nebr	24	36	60	2	4	6
St. Joseph, Mo	58	34	92	9	5	14
Kansas City, Kans	84	35	119	14	5	19
Missouri City, Mo	154	20	174	14	2	16
St. Louis, Mo	219	53	272	21	2	23
Monongahela River: Pittsburgh, Pa	3	35	38	0	0	0
North Platte River: Henry, Nebr	55	63	118	2	11	13
Ohio River:						
Addison, Ohio	3	21	24	0	0	0
Huntington, W. Va	4	23	27	0	0	0
Cincinnati, Ohio	8	26	34	2	0	2
Louisville, Ky	1	17	18	0	0	0
Evansville, Ind	13	30	43	0	0	0
Cairo, Ill	4	25	29	1	0	1
Toronto, Ohio	2	31	33	0	<1	<1
Ouachita River: Bastrop, La	13	27	40	0	0	0
Pend Oreille River: Albeni Falls Dam, Idaho	4	13	17	1	1	2
Platte River: Plattsmouth, Nebr	51	57	108	3	4	7
Potomac River:						
Williamsport, Md	1	24	25	0	1	1
Great Falls, Md	4	24	28	0	0	0
Washington, D. C	1	27	28	0	0	0
Rainy River:						
Baudette, Minn	23	64	87	0	0	0
International Fls., Minn	17	61	78	0	0	0
Red River, North:						
Grand Forks, N. Dak	11	77	88	1	2	3
Red River, South:						
Denison, Tex	4	32	36	0	3	3
Index, Ark	11	34	45	1	1	2
Bossier City, La	41	42	83	5	0	5
Alexandria, La	12	37	49	1	1	2
Rio Grande River:						
Alamosa, Colo	25	35	60	1	3	4
El Paso, Tex	76	41	117	10	6	16
Laredo, Tex	757	55	812	11	3	14
Brownsville, Tex	14	17	31	0	1	1
Roanoke River: John H. Kerr Resr. & Dam, Va	11	13	24	1	0	1
Sabine River: Ruliff, Tex	52	35	87	2	0	2
Sacramento River: Courtland, Calif	15	15	30	1	0	1
San Joaquin River: Vernalis, Calif	4	11	15	1	2	3
San Juan River: Shiprock, N. Mex	211	71	282	24	24	48
St. Lawrence River: Massena, N. Y	15	15	30	1	0	1
Schuylkill River: Philadelphia, Pa	10	39	49	0	0	0
Savannah River:						
North Augusta, Ga	16	12	28	1	0	1
Port Wentworth, Ga	24	39	63	0	0	0
Shenandoah River: Berryville, Va	43	19	62	1	0	1
Ship Creek: Anchorage, Alaska	2	8	10	0	0	0
Snake River:						
Ice Harbor Dam, Wash	4	17	21	0	1	1
Wawawai, Wash	6	16	22	0	1	1
Payette, Idaho	9	30	39	0	3	3
South Platte River: Julesburg, Colo	10	66	76	1	29	30
Spokane River: Post Falls, Idaho	7	10	17	0	0	0
Susquehanna River:						
Sayre, Pa	10	31	41	0	0	0
Conowingo, Md	2	16	18	0	0	0
Tennessee River:						
Lenoir City, Tenn	9	13	22	0	0	0
Chattanooga, Tenn	9	32	41	<1	<1	1
Bridgeport, Ala	2	26	28	0	0	0
Pickwick Landing, Tenn	18	23	41	1	0	1
Tombigbee River: Columbus, Miss	80	39	119	1	0	1
Truckee River: Farad, Calif	1	8	9	0	0	0
Verdigris River: Nowata, Okla	21	34	55	0	1	1
Wabash River: New Harmony, Ind	72	38	110	2	<1	2
Willamette River: Portland, Oreg	4	10	14	0	0	0
Yakima River: Richland, Wash	0	14	14	0	2	2
Yellowstone River: Sidney, Mont	141	37	178	15	2	17
Maximum	1284	258	1387	103	29	122
Minimum	0	0	4	0	0	0

Note: These data are preliminary; reanalysis of some samples and analyses which are not complete at the time of this report will be included in the network's *Annual Compilation of Data* (6).

radioactivity to which the population may be subjected. Data assembled through the Network are published in an annual compilation (*1-6*).

The participating agencies collect one-liter "grab" samples each week and ship them to the Public Health Service laboratory in Cincinnati for analysis. Determinations of gross alpha and gross beta radioactivity in the suspended and dissolved solids and of strontium–90 activity in the total solids are carried out on frequency schedules based on need.

Gross beta activity in each weekly sample was determined until January 1960, when the levels became essentially equal to background. Thereafter gross beta determinations were made on monthly composites of the weekly samples received from all stations, except those located downstream from known potential sources of radioactive waste and those from all newly established stations. (Weekly alpha and beta measurements are scheduled routinely during the first year of operation at newly established stations.) On September 1, 1961, weekly determinations of gross beta activity again were instituted to permit rapid detection of activity due to fallout from renewed weapons testing. This practice was continued until the end of October 1962, when samples for gross beta analysis were again composited monthly. Gross alpha determinations were made once monthly except where variable or high values observed during the first year indicated the need for more frequent measurement.

Normally, samples are counted at the Network laboratory within two weeks following collection or within one week after compositing. The decay of activity is followed on each sample showing unusually high activity during the first analysis. Also, if a recount indicates that the original analysis was questionable, values based on recounting are recorded. All results are reported for the time of counting and are not corrected by extrapolation to the time of collection.

The analytical method used for determining gross alpha and beta radioactivity is described in the eleventh edition of "Standard Methods for the Examination of Water and Wastewater" (*7*). Suspended and dissolved solids are separated by passing the sample through a membrane filter (type HA) with a pore size of 0.45 microns. Planchets are then prepared for counting the dissolved solids (in the filtrate) and the suspended solids (on the charred membrane filter) in an internal proportional counter. References sources of U_3O_8, which give a known count-rate if the instrument is in proper calibration, are used for daily checking of the counters.

Since the fourth quarter of 1958, strontium–90 analyses have been made on three-month composites of aliquots from weekly samples. Until the fourth quarter of 1961, the method used for determining strontium–90 was that described in the aforementioned reference (*7*). Tributyl phosphate was used to extract ingrown yttrium–90 from the purified, coprecipitated strontium–90. Since that time, a modification of a procedure described by Harley has been used (*8*). The yttrium–90, together with an yttrium carrier, is precipitated at pH 8.5; the precipitate is washed, redissolved, and reprecipitated as yttrim oxalate and the latter is washed and counted in a low-background, anticoincidence, end-window proportional counter.

Table 1 presents July 1963 results of alpha and beta analyses of U.S. raw surface waters. These data are preliminary; reanalysis of some samples and some analyses which are not completed at the time of this report will be included in the Network's *Annual Compilation of Data* (*6*). The figures for gross alpha and gross beta radioactivity represent either determinations made on composite samples or means of weekly determinations where composites were not made. The quarterly strontium–90 results for the past year are presented in table 2.

In order to obtain a geographical perspective of the radioactivity in surface water, the numbers alongside the various stations in figure 1 give the July 1963 average total beta activity in suspended-plus-dissolved solids in raw water collected at that station. Network results for the years 1957–1962 have been summarized by Weaver *et al* (*9*).

REFERENCES

(*1*) Division of Water Supply and Pollution Control, Public Health Service: *National Water Quality Network Annual Compilation of Data*, PHS Publication No. 663, 1958 Edition, Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $1.50.

(*2*) *Ibid.*, 1959 Edition. Price $1.75.

TABLE 2.—QUARTERLY STATION AVERAGE CONCENTRATIONS OF STRONTIUM-90 IN RAW SURFACE WATERS, JULY 1962–JUNE 1963

[Concentrations in pc/liter]

Station	Third Quarter 1962	Fourth Quarter 1962	First Quarter 1963	Second Quarter 1963
Allegheny River: Pittsburgh, Pa	2.1	1.8	[a]—	1.8
Animas River: Cedar Hill, N. Mex	0.4	0.9	—	—
Apalachicola River: Chattahoochee, Fla	0.4	0.4	—	—
Arkansas River				
Coolidge, Kansas	2.6	1.0	—	—
Ponca City, Okla	4.8	2.2	—	5.9
Pendleton Ferry, Ark				5.5
Bear River: Preston, Idaho	[b]1.3	0.9	—	—
Big Horn River: Hardin, Mont	3.7	1.3	—	5.8
Big Sioux River: Sioux Falls, S. Dak	5.4	2.5	—	—
Chattahoochee River				
Atlanta, Ga	0.7	1.0	3.6	1.6
Columbus, Ga	[c]0.8	1.1	—	1.5
Lanett, Ala	1.5	0.8	—	—
Chena Slough: Fairbanks, Alaska	0.4	0.3	—	0.7
Clearwater River: Lewiston, Idaho	0.5	0.4	—	—
Clinch River				
Clinton, Tenn	1.3	1.0	6.3	—
Kingston, Tenn	12.6	—	—	5.6
Colorado River				
Yuma, Ariz	1.2	0.9	—	0.9
Parker Dam, Ariz.-Calif	1.7	1.3	—	—
Boulder City, Nev	1.7	1.5	—	1.8
Page, Ariz	1.5	6.9	1.5	—
Loma, Colo	0.8	0.5	—	2.5
Columbia River				
Clatskanie, Oreg	0.6	0.9	—	1.3
Bonneville, Oreg	0.4	1.2	—	—
McNary Dam, Oreg	1.4	1.0	1.4	1.1
Pasco, Wash	1.8	1.5	2.3	2.4
Wenatchee, Wash	1.2	1.6	—	1.1
Northport, Wash	1.3	0.9	—	—
Connecticut River				
Northfield, Mass	1.3	1.0	—	1.4
Enfield Dam, Conn	1.4	1.0	—	—
Wilder, Vt	1.4	0.9	—	—
Cuyahoga River: Cleveland, Ohio		—	1.4	—
Delaware River				
Philadelphia, Pa	1.6	2.4	—	1.1
Martins Creek, Pa	0.5	1.2	—	1.7
Trenton, N. J	1.5	0.9	—	
Escambia River: Century, Florida	1.0	—	—	1.4
Great Lakes:				
Lake Superior:				
Duluth Minn	0.7	0.7	—	0.4
St. Marys River:				
Sault Ste. Marie, Mich	0.9	0.8	—	—
Lake Michigan:				
Milwaukee, Wis	0.9	0.8	—	0.8
St. Clair River:				
Port Huron, Mich	1.0	0.8	—	1.3
Lake Erie:				
Buffalo, N. Y	1.3	1.7	—	2.2
Detroit River:				
Detroit, Mich	1.5	1.1	—	—
Lake Michigan:				
Gary, Ind	1.0	0.7	—	—
Green River: Dutch John, Utah	1.9	1.2	—	—
Hudson River: Poughkeepsie, N. Y	1.7	3.0	—	3.8
Illinois River				
Pere Marquette State Park				
Grafton, Ill	1.4	1.8	—	—
Peoria, Ill		1.7	—	3.5
Kanawha River: Winfield Dam, W. Va	1.3	1.1	—	—
Klamath River: Keno, Oreg	2.8	0.9	—	1.4
Kansas River: De Soto, Kans	—	—	—	4.9
Little Miami River: Cincinnati, Ohio	0.9	1.6	—	—
Maumee River: Toledo, Ohio	—	—	3.6	4.9
Merrimack River: Lowell, Mass	—	0.9	—	—
Mississippi River				
New Orleans, La	2.1	1.9	—	—
Vicksburg, Miss	2.0	2.0	—	—
Delta, La	1.1	2.1	—	3.3
W. Memphis, Ark	2.4	2.0	—	3.6
Cape Girardeau, Mo	3.1	2.7	—	—
East St. Louis, Ill	2.7	1.8	—	4.0
Burlington, Iowa	2.1	2.1	—	—
Dubuque, Iowa	—	—		2.6
Lock & Dam #3, St. Paul, Minn	4.9	3.4	—	—
Missouri River				
St. Louis, Mo	2.5	2.7	—	—
Missouri City	2.2	2.6	—	4.1
Kansas City, Kans	3.4	3.4	—	—
St. Joseph, Mo	5.7	1.9	—	6.2
Omaha, Nebr	3.8	2.5	—	—
Yankton, S. Dak	2.3	2.3	—	3.3
Bismarck, N. Dak	1.4	1.7	—	—
Williston, N. Dak	3.0	1.5	—	2.5
Monongahela River: Pittsburgh, Pa	1.8	1.5	—	2.7
North Platte River: Henry, Nebr	2.1	0.6	—	2.5
Ohio River				
Cairo, Ill	1.4	1.7	—	2.9
Evansville, Ind	1.3	1.6	—	—
Louisville, Ky	3.3	1.4	—	2.3
Cincinnati, Ohio	1.5	1.6	—	—
Huntington, W. Va	1.5	1.6	—	1.9
Addison, Ohio	1.3	2.1	—	—
E. Liverpool	—	—	—	
Toronto, Ohio				—
Ouachita River: Bastrop, La	1.0	1.6	—	—
Pend Oreille River: Albeni Falls Dam, Idaho	0.5	0.7	—	0.9
Platte River: Plattsmouth, Nebr	4.1	2.3	—	—
Potomac River				
Great Falls, Md	1.2	1.0	—	—
Williamsport, Md	1.2	1.6	—	1.4
Washington, D. C				—
Rainy River				
International Falls, Minn	1.4	1.8	—	2.9
Baudette, Minn	1.7	2.2	—	2.5
Red River (South)				
Alexandria, La	2.0	3.9	—	4.0
Bossier City, La	2.2	2.0	—	—
Index, Ark	—	3.3	—	5.3
Denison, Tex	1.1	5.0	—	—
Rio Grande River				
Alamosa, Colo	0.5	0.5	—	1.1
El Paso, Tex	1.7	0.7	—	—
Laredo, Tex	1.8	1.8	—	3.7
Brownsville, Tex	0.7	1.3	—	—
Roanoke River: John H. Kerr Resr. & Dam, Va	1.8	1.1	—	1.3
Sabine River: Ruliff, Tex	1.0	1.4	—	—
Sacramento River				
Greens Landing, Calif	0.8	0.9	—	
Courtland, Calif				—
San Joaquin River: Vernalis, Calif	0.7	1.0	—	1.3
San Juan River: Shiprock, N. Mex	1.0	1.7	—	1.9
Savannah River				
Port Wentworth, Ga	2.2	0.6	2.4	2.2
North Augusta, Ga	0.8	0.6	—	—
Schuylkill River: Philadelphia, Pa	1.8	1.3	—	—
Shenandoah River: Berryville, Va	0.4	0.8	—	1.2
Ship Creek: Anchorage, Alaska	—	0.3	—	—
Snake River				
Ice Harbor Dam, Wash	1.1	1.6	—	—
Wawawai, Wash	0.9	0.7	—	0.9
Payette, Idaho	1.1	0.8	—	1.5
South Platte River: Julesburg, Colo	2.2	0.8	—	1.7
Spokane River: Post Falls, Idaho	0.9	0.8	—	—
Susquehanna River				
Conowingo, Md	2.1	1.2	—	1.6
Sayre, Pa	1.0	1.0	—	—
Tennessee River				
Pickwick Landing Dam, Tenn	1.1	1.4	—	—
Bridgeport, Ala	0.6	1.0	—	1.6
Chattanooga, Tenn	1.2	1.4	2.6	1.7
Lenoir City, Tenn	2.8	1.0	—	1.5
Tombigbee River: Columbus, Miss	1.6	0.6	—	—
Truckee River: California-Nevada Border Farad, Calif	0.7	0.9	—	1.0
Verdigris River: Nowata, Okla	2.3	2.5	—	4.2
Wabash River: New Harmony, Ind	2.0	1.4	—	3.1
Willamette River: Portland, Wash	0.5	0.6	—	0.7
Yakima River: Richland, Wash	0.3	0.7	—	—
Yellowstone River: Sidney, Mont	1.5	2.0	—	—
Maximum	12.6	6.9	6.3	6.2
Minimum	0.3	0.3	0.4	0.4

[a] Dash indicates no data received.
[b] Aug.-Sept. composite.
[c] Six months composite.

(3) *Ibid.*, 1960 Edition.[1]

(4) *Ibid.*, 1961 Edition.[1]

(5) *Ibid.*, 1962 Edition (in press).

(6) *Ibid.*, 1963 Edition (to be published).

(7) American Public Health Association, American Water Works Association and Water Pollution Control Federation: *Standard Methods for the Examination of Water and Wastewater*, 11th Edition New York (1960).

(8) Harley, J. H.: Radiochemical Determination of Strontium–90, *Health and Safety Laboratory Manual of Standard Procedures*, August 1962 Revision, Radiochemistry and Environmental Studies Division, U.S. Atomic Energy Commission, New York Operations Office (1962).

(9) Weaver, L., A. W. Hoadley, and S. Baker: Radioactivity in Surface Waters of the United States, 1957–1962, *Radiological Health Data*, 4: 306–16, Superintendent of Documents. Government Printing Office, Washington 25, D.C. (June 1963).

[1] Single free copies of this publication may be obtained from: Public Inquiries Branch, Public Health Service, U.S. Department of Health, Education, and Welfare, Washington 25, D.C.

Radiostrontium in Tap Water, January–April 1963[1]

Health and Safety Laboratory
U.S. Atomic Energy Commission

The Health and Safety Laboratory has performed analyses for strontium–90 concentrations in tap water at New York City since August 1954 and at Richmond, California since April 1958. Samples of tap water are collected daily at each site so that by the end of the month a composite of at least 100 liters is available for analysis. Also, determinations of strontium–89 have been made since September 1961 (*1*).

Data for the past several years are plotted in figure 1. Data prior to 1958 appear in an earlier HASL report (*2*). Strontium–90 concentrations and strontium–89/strontium–90 ratios for January through April 1963 appear in table 1.

Monthly average strontium–90 concentra-

[1] Data taken from *HASL–140* (*1*).

TABLE 1.—RADIOSTRONTIUM IN TAP WATER

Month	New York City[a]		Richmond, California[b]	
	Sr^{90} (pc/liter)	Sr^{89}/Sr^{90}	Sr^{90} (pc/liter)	Sr^{89}/Sr^{90}
1959 Average	0.40		0.29	
1960 Average	0.47		0.26	
1961 Average	0.32		0.25	
1962 Average	0.72		0.23	
1963				
January	0.94	6.2	0.24	7.4
February	0.52	5.4	0.28	8.5
March	1.03	4.3	0.36	7.8
April	1.07	4.7	lost	lost

[a] From 100–200 liters per sample.
[b] Approximately 100 liters per sample.
Note: Strontium–89 extrapolated to midpoint of sampling period.

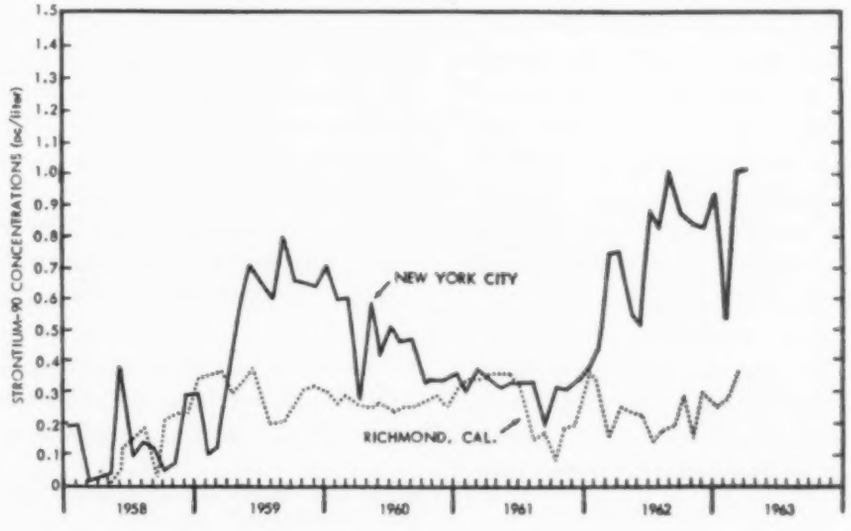

FIGURE 1.—STRONTIUM–90 CONCENTRATIONS IN TAP WATER

tions in tap water at New York City which averaged 0.72 pc/liter during 1962 had increased to 1.07 pc/liter by April 1963. Levels at Richmond, California, which normally are lower than those observed in New York City, ranged between 0.24 and 0.36 pc/liter during the first four months of 1963.

The strontium–89/strontium–90 ratios indicate that the fallout was probably not of any more recent origin when strontium–90 concentrations were high than when they were low.

The maximum strontium–90 concentrations observed are well below the acceptable limit of 10 pc/liter as set forth in the interstate carrier drinking water standards (*3*).

REFERENCES

(*1*) U.S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–140*: 154, Office of Technical Services, Department of Commerce, Washington, D.C., 20230, (October 1, 1963), price $4.00.

(*2*) U.S. Atomic Energy Commission: *Environmental Contamination from Weapons Tests, HASL–42*, Office of Technical Services, Department of Commerce, Washington, D.C. 20230, (October 1962), price $3.50.

(*3*) Federal Register Rules and Regulations: *Title 42—Public Health* Chapter 1—Public Health Service, Department of Health, Education, *and Welfare*; *Part 72, Interstate Quarantine, Subpart J, Drinking Water Standards, 27*: 2154–5, Superintendent of Documents, Government Printing Office, Washington, D.C., 20401 (March 6, 1962).

Recent coverage in *Radiological Health Data*:

Period	Issue
Second quarter 1961	*March 1962*
Third and fourth quarters 1961	*June 1962*
January–April 1962	*September 1962*
March–June 1962	*January 1963*
July–December 1962	*July 1963*

SECTION IV.—OTHER DATA

Preliminary Survey of Dairy Cattle Feeding Practices

Carl D. Olsen[1]

Information on dairy cattle feeding practices is necessary in the development of mathematical models for predicting radionuclide concentrations in milk. Additionally, the feeding practices are of importance for investigating the mechanisms by which radionuclides move from the environment into milk. Some reports suggest that modification of these feeding practices may permit some control of the radionuclide content of milk (*1–4*). The above reasons prompted a preliminary survey of dairy cattle feeding practices which was conducted during the first half of 1963 by the Division of Environmental Engineering and Food Protection, PHS.

The data obtained through the survey of feeding and pasture practices are presented in figure 1. This figure shows the average periods during which dairy cattle are on pasture in various areas of the country. These periods are approximate and will vary from year to year, depending on individual farming practice, rainfall, elevation, and seasonal temperature deviations.

The data were obtained from dairy extension agents, dairy nutritionists, and health department personnel in Alabama, Arkansas, Georgia, Louisiana, Mississippi, Nebraska, New Mexico, Oklahoma, and Texas. Public Health Service personnel furnished similar data for California, Florida, Idaho, Maryland, Michigan, Oregon, Washington and Wisconsin. The data were plotted on maps furnished by the U.S. Weather Bureau, and the pasture dates were interpolated along the lines of the average dates of the first frost in the fall, or the last average frost date in the spring. For the purposes of this report, pasture periods are considered to be those periods when the cattle are receiving 75 percent or more of their roughage from grazing or from fresh, chopped, green feed.

It was found that those areas along the Gulf Coast, the East Coast north to the southern border of North Carolina, the West Coast, and the San Joaquin and Sacramento valleys of California pasture their cattle all year around, except for certain areas of high land value where the cattle are fed in a "dry lot." These latter areas include the southern tip of Texas and the environs of Los Angeles. Arid areas such as New Mexico, Arizona and the El Paso, Texas, and Las Vegas, Nevada, areas are also predominantly dry lot feeding areas. Here the forage is grown on irrigated land, and is cut and carried to the cattle in a dry lot.

In general, there was little, if any, summer carry-over of stored feed in the Southern States. The mild climate of the South permits most

[1] Dr. Olsen is Staff Veterinarian, Milk and Food Branch, Division of Environmental Engineering and Food Protection, Public Health Service, Department of Health, Education and Welfare, Washington, D.C. 20201.

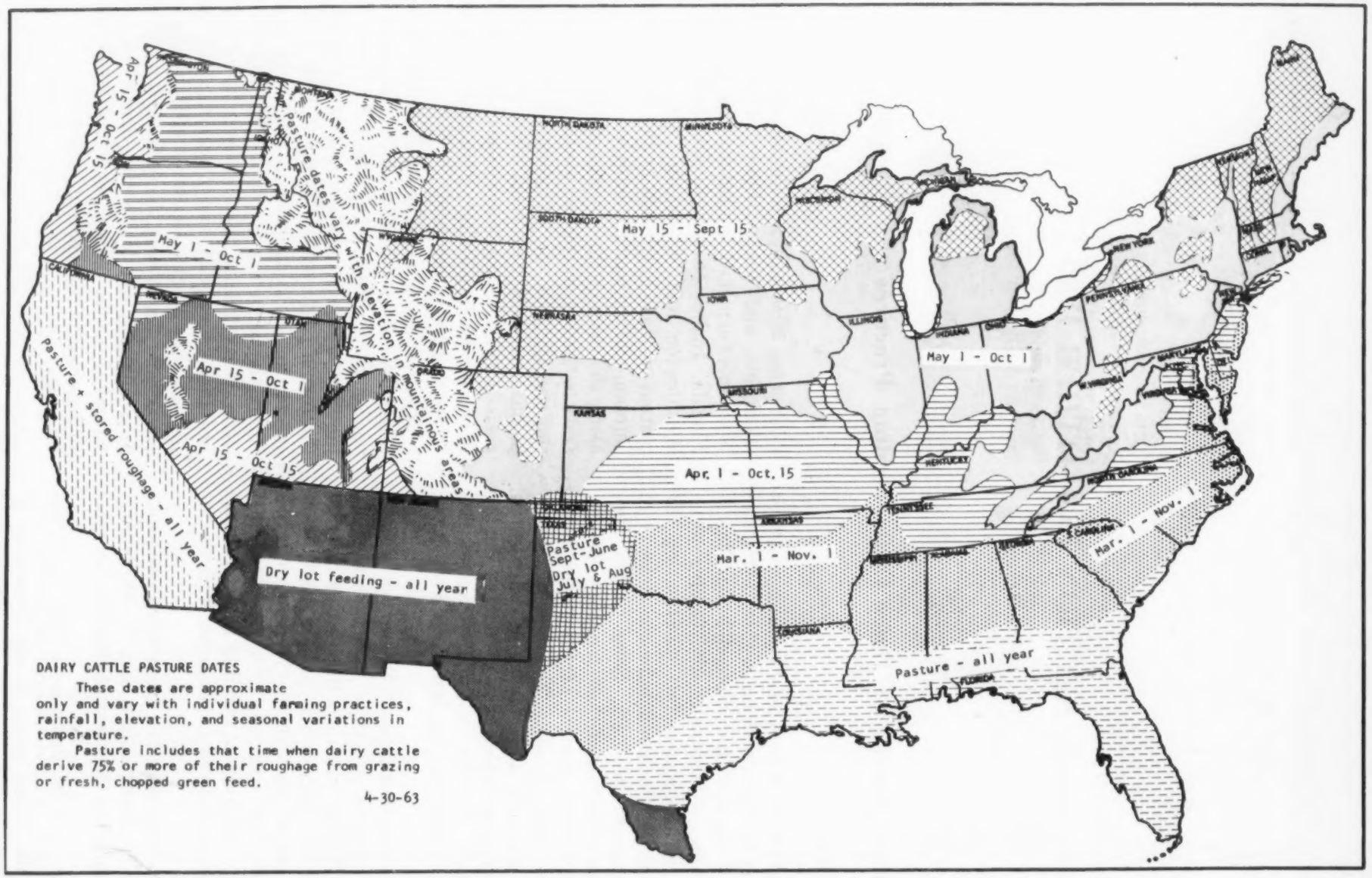
Apr 15 - Oct 15
Pasture dates vary with elevation in mountainous areas
May 1 - Oct 1
May 15 - Sept 15
May 1 - Oct 1
Apr 15 - Oct 1
Apr 15 - Oct 15
Pasture + stored roughage - all year
Apr. 1 - Oct. 15
Dry lot feeding - all year
Pasture Sept-June
Dry lot July & Aug
Mar. 1 - Nov. 1
Mar. 1 - Nov. 1
Pasture - all year
DAIRY CATTLE PASTURE DATES
These dates are approximate only and vary with individual farming practices, rainfall, elevation, and seasonal variations in temperature.
Pasture includes that time when dairy cattle derive 75% or more of their roughage from grazing or fresh, chopped green feed.
4-30-63

FIGURE 1.—APPROXIMATE DATES DAIRY CATTLE ARE ON PASTURE

dairymen to get by on a minimum of stored feed. In the northern half of the country, normal dairy practice is to store enough hay for the winter months, plus a little extra. Generally, dairymen carry over about a 30-day supply of stored feed to the following year. The rainfall, length of winter, and length of summer pasture seasons will cause the amount of carryover to vary somewhat from year to year.

Winter housing varies with the region. In the Northern States' snow belt, the cattle are generally confined to the barn during those months when there is snow cover on the pastures. In those States south of the snow belt, the housing is usually of the shed type with one side open and the cattle are permitted to roam or graze old pastures or cornfields. In most areas of the South and Southwest, housing for cattle is minimal.

This limited investigation into dairy cattle feeding practices on a national basis was based on the collection and collation of the average periods during which dairy cattle receive 75 percent or more of their roughage from grazing or from fresh, chopped, green feed. For a more precise description of dairy cattle feeding practices these data must be supplemented by data from individual farms and for specific years.

REFERENCES

(*1*) National Advisory Committee on Radiation: *Radioactive Contamination of the Environment: Public Health Action,* Division of Radiological Health, Public Health Service, U.S. Department of Health, Education and Welfare, Washington, D.C. 20201. (May 1962).

(*2*) Minnesota Department of Health and University of Minnesota: *Factors Influencing Strontium–90 in Milk From the Brainerd, Minn. Milkshed,* PHS Publication No. 999–R–1, Public Inquiries Branch, Public Health Service, U.S. Department of Health, Education and Welfare, Washington, D.C. 20201 (December 1962).

(*3*) Hansen, W. G., J. E. Campbell, J. H. Fooks, H. C. Mitchell, and C. B. Eller: *Influence of Farming Practices on Concentrations of Fission Products in Milk,* Public Health Service Publication 999–R–6, to be published.

(*4*) Kahn, B., C. P. Straub and I. R. Jones: *Radioiodine in Milk of Cows Consuming Stored Feed and of Cows on Pasture: Science 138*: 1334–5, (December 1962).

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U. S. Atomic Energy Commission receives from its contractors quarterly reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 21 AEC installations have appeared periodically in *Radiological Health Data* since November 1960. A summary follows for Hanford Atomic Products Operation.

The measured concentration of a radionuclide in air and water may be compared with the Maximum Permissible Concentration (MPC) of that nuclide as recommended by the National Committee of Radiation Protection and Measurement (NCRP). For the environment near an AEC installation, the applicable MPC's are one-tenth of the occupational MPC values for continuous exposure given in National Bureau of Standards "Handbook 69." The MPC values applicable to the following reports are given in table 1.

HANFORD ATOMIC PRODUCTS OPERATION,[1] CALENDAR YEAR 1962

General Electric Co.
Richland, Washington

The Hanford Atomic Products Operation, located in a semi-arid region of southeastern Washington, is a 500-square mile complex of nuclear reactors, fuel fabrication plants, chemical separation facilities and research and development laboratories. Various radioactive wastes which result from plant operations are disposed of through controlled releases to the atmosphere, ground, and the water of the Columbia River. A primary responsibility of plant personnel is to monitor effluents in order to safeguard against any effects these wastes have on the 80,000 residents of Richland, Pasco, Kennewick, and other communities in the vicinity of the project.

[1] Summarized from Hanford Atomic Products Operation, *Evaluation of Radiological Conditions in the Vicinity of Hanford for 1962*, HW–76526, February 25, 1963.

TABLE 1.—SELECTED ENVIRONMENTAL MPC VALUES PERTAINING TO AEC INSTALLATION REPORTS IN THIS SUBSECTION

Line No.	Radionuclide or mixture of unknown nuclides	Environmental MPC's	
		Water (pc/liter)	Air (pc/m³)
1	If Sr^{90}, I^{129}, Pb^{210}, Po^{210}, At^{211}, Ra^{223}, Ra^{224}, Ra^{226}, Ac^{227}, Ra^{228}, Th^{230}, Pa^{231}, Th^{232}, and Th-nat are not present[a]	3,000	—
2	If Sr^{90}, Pb^{210}, Ra^{226}, Ra^{228} are not present[a]	600	—
3	If Ra^{226}, Ra^{228} are not present[a]	100	—
4	Mixture of unidentified nuclides	10	0.04
5	If α emitters and Ac^{227} are not present[a]	—	1.0
6	If α emitters and Pb^{210}, Ac^{227}, Ra^{228}, Pu^{241} are not present[a]	—	10
7	If α emitters and Sr^{90}, I^{129}, Pb^{210}, Ac^{227}, Ra^{228}, Pa^{230}, Pu^{241}, Bk^{249} are not present[a]	—	100
8	Arsenic-76	20,000	3,000
9	Copper-64	200,000	40,000
10	Chromium-51	2,000,000	80,000
11	Iodine-131[b]	2,000	300
12	Manganese-56	100,000	20,000
13	Neptunium-239	100,000	30,000
14	Phosphorus-32	20,000	2,000
15	Silicon-31	5,000	0.06
16	Sodium-24	200,000	30,000
17	Strontium-90[b]	100	10
18	Zinc-65	100,000	2,000

[a] "Not present" implies the concentration of the nuclide is small compared with its appropriate MPC. According to AEC regulations, a group of nuclides may be considered not present if the ratio of each nuclide is equal to or less than 1/10 of its appropriate MPC and if the sum of these ratios for the group in question is equal to or less than ¼.
[b] The Federal Radiation Council guidance is expressed in terms of daily intake. The top of Range II is 100 pc/day for Iodine-131 and 200 pc/day for strontium-90.

The monitoring program includes surveillance of the atmosphere, vegetation, fish and wildlife, milk and agricultural produce, and the waters of the Columbia River and Pacific Ocean. Further measurements are made of external radiation and possible ground contamination from burial pits.

Atmosphere

Gaseous wastes are released to the atmosphere through 200-foot stacks after removal of most radioactive material orginally present.

The Hanford project maintains air sampling stations at Benton City, Kennewick, Pasco, Richland, Seattle, Spokane, Walla Walla, and Yakima, Washington; Meacham, and Klamath Falls, Oregon; Boise and Lewiston, Idaho; and Great Falls, Montana. Sample filters are changed weekly and sent to Hanford for analyses. Quarterly averages of beta concentration during 1962 are presented in table 2.

Releases of iodine–131 are of particular interest and routine measurements are made at several locations around the plant area. Stack releases averaged 0.35 curies per day in 1962. The concentrations in the local environmental air are shown in table 3.

Water

Hanford's eight production reactors are cooled by treated water pumped from the Columbia River. After the water passes through the reactors, it is returned to the river. Some radioactivity results from neutron activation of impurities remaining in the treated water and is discharged in the effluent. The major part (90 percent) of this radioactive material consists of Mn^{56}, Cu^{64}, Na^{24}, Cr^{51}, Np^{239}, As^{76}, and Si^{31}. Although the presence of Zn^{65}, P^{32}, and certain other radionuclides is of interest, they are found in lower quantities. River water samples are taken at Hanford Ferry, Pasco, and Vancouver to be analyzed for several radionuclides. Selected results are presented in table 4.

TABLE 2.—AVERAGE AIRBORNE BETA ACTIVITY AT SELECTED PACIFIC N.W. LOCATIONS, 1962

[Average concentrations in pc/m³]

Sampling locations	First quarter	Second quarter	Third quarter	Fourth quarter
Richland, Washington	6.4	4.5	4.4	7.3
Spokane, Washington	4.1	3.6	3.4	3.8
Boise, Idaho	5.7	5.4	4.5	9.4
Meacham, Oregon	5.3	4.4	4.9	7.8
Seattle, Washington	3.6	2.6	2.3	6.2

TABLE 3.—IODINE–131 IN AIR AT PERIMETER COMMUNITIES

[Average concentrations in pc/m³]

Sampling locations	1960	1961	1962	1962			
				1st quarter	2nd quarter	3rd quarter	4th quarter
Richland	0.030	0.023	0.038	0.028	0.024	0.056	0.030
North Richland	0.043	0.045	0.099	0.085	0.088	0.100	0.091
Benton City	0.054	0.022	0.081	0.018	0.073	0.126	0.108
Pasco	0.023	0.036	0.077	0.068	0.024	0.109	0.113

TABLE 4.—CONCENTRATIONS OF SELECTED RADIONUCLIDES IN THE COLUMBIA RIVER WATER, 1962

[Concentrations in pc/liter]

Sampling location	Calendar year 1962	Na^{24}	P^{32}	Zn^{65}	As^{76}	I^{131}	Np^{239}
Hanford Ferry	Maximum	11,000	600	1,800	4,800	34	3,900
(raw water)	Minimum	610	86	150	620	5.4	690
(24 samples)	Average	6,100	260	420	1,500	12	2,100
Pasco	Maximum	2,400	590	510	660	11	1,900
(raw water)	Minimum	170	50	110	180	<1.4	340
(27 samples)	Average	1,600	180	220	470	<6	980
Pasco	Maximum	1,400	210	270	420	17	1,300
(treated domestic water)	Minimum	89	<2.6	<11	<50	<1.1	[a]
(50 samples)	Average	600	44	95	<200	<6	550
Vancouver	Maximum		110	140			180
(raw water)	Minimum		8.4	<15			[a]
(19 samples)	Average	[b]	38	64	[b]	[b]	77

[a] Not detected.
[b] Not analyzed.

Fish and Wildlife

Fish in the Columbia River accumulate some of the radionuclides present in water, and whitefish in particular concentrate phosphorus–32, which is a major bone seeker. The average concentration of phosphorus–32 in the flesh of whitefish caught near the plant was 350 pc/g, somewhat lower than the 530 pc/g average for 1961.

Migratory waterfowl which may have utilized the Hanford section of the Columbia River were obtained from hunters in Washington, Oregon, Idaho, and California. Analyses of 102 of these specimens showed that one out of 17 contained concentrations of phosphorus–32 greater than the detection level of 50 pc/g. The maximum concentration found was 1,800 pc P^{32}/g.

Milk and Agricultural Produce

There is no farming within about a 13–mile radius of the chemical separations facilities (the major local source of air-borne radionuclides), but the Ringold farms and Riverview District of Pasco, which are respectively about 15 and 30 miles downstream from the reactors, take water from the Columbia River. Some radionuclides, especially Zn^{65} and P^{32}, are traced through the irrigation process into milk and produce.

Dairy farms in the Ringold and Riverview areas were found to have average Zn^{65} concentrations in milk of 960 pc/liter and 590 pc/liter, respectively, and the average P^{32} concentrations were 760 pc/liter and 850 pc/liter, respectively. Neither Zn^{65} nor P^{32} was positively detected in milk distributed through commercial outlets.

Hanford analyses of milk known to be of local origin showed Sr^{90} concentrations ranging from less than 2 to 24 pc Sr^{90}/liter, with an average concentration of 5.1 pc Sr^{90}/liter. Concentrations of Sr^{89} and Cs^{137} in milk analyzed at Hanford were usually below the detection levels of 4 pc Sr^{89}/liter and 30 pc Cs^{137}/liter.

With the exception of the P^{32} and Zn^{65} in milk obtained from local farms irrigated with Columbia River water, the radionuclide content of milk available commercially in the area appears typical of that reported by Public Health Service for sections of the country with similar rainfall.

In addition to the above nuclides, measurements for I^{131} were made in all milk samples. During the early part of the year, concentrations of I^{131} in local milk were well below 10 pc/liter. Nuclear tests by the U.S. during the spring and early summer caused temporary increases in concentrations of I^{131} in local milk to a maximum of 70 pc/liter. A sharp rise in I^{131} concentrations occurred during the latter part of August and in September in both local and commercial milk coincident with the resumption of nuclear testing by the U.S.S.R. On October 31, a maximum concentration of 580 pc I^{131}/liter was measured in milk from the Ringold area. Relatively high concentrations persisted until the latter part of December, at which time the I^{131} content dropped to less than 10 pc/liter of milk. Radioactive decay of I^{131} and the decreased use of fresh pasture accounts for the sharp reduction of I^{131} measured in milk at the end of the year.

Miscellaneous local produce was purchased periodically from the markets and farms during the growing season and radioassayed. The average concentration of I^{131} measured in leafy vegetables sampled from local farms and vegetable markets during the period of May through September was 200 pc/kg.

External Radiation

Ionization chambers located above ground and in the Columbia River were used to estimate the combined exposure from external sources in the Hanford area. Aboveground measurements indicated an annual exposure in 1961 of about 170 mr. Virtually all of this radiation is attributable to natural background.

The presence of gamma emitters, especially Na^{24}, in reactor effluent causes a higher exposure rate in the Columbia River. The average dose in the water near Richland was about 2.1 mr/day and near Pasco about 1.4 mr/day. This would mean that a person swimming or boating in the river for 240 hours per year would receive about 20 mr of exposure near Richland.

Previous coverage in *Radiological Health Data*

Period	Issue
1959 and first and second quarters 1960	*May 1961*
Third and fourth quarters 1960 and first and second quarters 1961	*February 1962*
Third and fourth quarter 1961	*October 1962*

Reported Nuclear Detonations, December 1963

Two low-yield underground nuclear detonations at the Nevada Test Site during December 1963 were reported by the Atomic Energy Commission. The first of these, conducted on December 4, 1963, was given the arbitrary reference number 146 by *Radiological Health Data*; the other test, conducted on December 12, was assigned reference number 147. (Low yield range has been defined as less than 20 kilotons.)

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UNITS AND EQUIVALENTS

Symbol	Unit	Equivalent
Bev	billion electron volt	
cpm	count per minute	
dpm	disintegration per minute	
g	gram	
kg	kilogram	1 kg = 1000 gm = 2.2 pounds
km^2	square kilometer	
kvp	kilovolt peak	
m^3	cubic meter	1 m^3 = 1000 liters
ma	millampere	
mas	milliampere-second	
Mev	million electron volts	
mi^2	square mile	
ml	milliliter	
mm	millimeter	
mrad	millirad	
mrem	millirem	
mr/hr	milliroentgen per hour	
mμc	millimicrocurie	1 mμc = 1 nc
nc	nanocurie	1 nc = 1000 pc = 1 mμc = 10^{-9} curies
nc/m^2	nanocurie per square meter	1 nc/m^2 = 1 $mμc/m^2$ = 1,000 $μμc/m^2$ = 1 mc/km^2 = 2.59 mc/mi^2
pc	picocurie	1 pc = 1 μμc = 10^{-12} curies
r	roentgen	
μμc	micromicrocurie	1 μμc = 2.22 dpm

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr′ a
10^{9}	giga	G	jĭ′ ga
10^{6}	mega	M	mĕg′ a
10^{3}	kilo	k	kĭl′ o
10^{2}	hecto	h	hĕk′ to
10	deka	da	dĕk′ a
10^{-1}	deci	d	dĕs′ ĭ
10^{-2}	centi	c	sĕn′ tĭ
10^{-3}	milli	m	mĭl′ ĭ
10^{-6}	micro	μ	mī′ kro
10^{-9}	nano	n	năn′ o
10^{-12}	pico	p	pē′ co
10^{-15}	femto	f	fĕm′ to

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